LOUISVILLE

GREENHOUSE GAS EMISSIONS REDUCTION PLAN

APRIL 2020

SUSTAIN Louisville

Louisville Forward

(Intentionally left blank)

Prepared by:

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

Letter from the Mayor

Every day, we are reminded of the challenges we collectively face from climate change. In our community, changing climate patterns are likely to increase the frequency of heat waves, severe storms, flooding, and drought. In recognition of our contribution to climate change and our responsibility to lessen its impacts, I signed the Global Covenant of Mayors for Climate & Energy on Earth Day 2016. By making this pledge, Louisville Metro joined with thousands of cities across the globe to accelerate progress toward a low-emission and climate-resilient future.

As the first step to this commitment, Louisville Metro completed an updated Greenhouse Gas (GHG) Inventory in 2016. This inventory describes the current sources of GHG emissions generated within the political boundaries (i.e., geography) of Louisville Metro, which will inform how what approaches we take to reduce them. The *Louisville Greenhouse Gas Emissions Reduction Plan* (ERP) is the second component of our commitment to the Global Covenant of Mayors, and describes how we plan to meet our GHG emissions reduction target.

Our commitment

We are proud to continue our commitment with our peer cities around the world in setting a science-based target to reduce our GHG emissions in line with the Paris Agreement. The ERP establishes a blueprint to achieve an 80% reduction in our community-wide GHG emissions by 2050; however, since setting this target in 2018, more recent data have provided insight on the GHG reductions needed to keep global warming below 1.5°C to avoid the most catastrophic effects of climate change. To limit temperature rise in accordance with the Paris Agreement, GHG emissions must be halved by 2030 and reach net zero emissions by 2050 (IPCC, 2018). Louisville Metro supports this goal and will work with both internal and external partners to do all we can to reach these targets.

We recognize that achieving the necessary reductions will require us to collaborate with our community partners, support and spur local creativity and innovation, and carefully consider how our commitment will influence and impact our economy. At the same time, we know the status quo poses a risk to our economy and way of life. Failing to act will reduce the quality of life of our residents, worsen the impacts on our most vulnerable populations, and limit the ability of our local businesses to benefit from innovation and new technology from the new green economy.

How we will get there

Limiting global warming to 1.5°C will require rapid, far-reaching and unprecedented change – change in the way we generate and use energy, change in how we travel, and change in how we collect and manage our waste. The Louisville of the future must be focused on protecting our most vulnerable and improving the health and quality of life for all residents. The COVID-19 pandemic is a tragedy that has struck our global economy and local community, causing fear, isolation and even death; however, it has also demonstrated the strength of our community to face a crisis head-on with urgent action.

Following this health and economic crisis, we have the opportunity to build our city back cleaner, greener, and stronger than ever before.

To accomplish this goal, we will need to work to remove barriers to allow new and increased opportunities for residents and businesses to use renewable energy, plant more trees, increase transit availability and opportunities for cycling and walking, and make it easier for residents to own and operate electric vehicles.

Our approach has been informed through consultation with numerous stakeholders, and we know that many residents and businesses are already taking action. By working together, we are optimistic that we can meet these targets.

We Are Already on Our Way

Since 2010, our community has already made significant reductions in GHG emissions. Over a six-year timeframe, our community emissions fell by approximately 10%. Major accomplishments that helped us achieve this reduction include an increase in automobile efficiency and a reduction in the carbon intensity of electricity supplied by Louisville Gas and Electric (LG&E), largely due to a switch from coal to natural gas at the Cane Run generation facility. New efforts already underway are continuing our reduction, including the new Bus Rapid Transit (BRT) line on Dixie Highway and the proliferation of electric vehicles. This success shows that we are well-positioned to take future action to reduce GHG emissions.

Implementing this ERP will result in a future Louisville that is healthy and attractive to residents and businesses alike. We are committed to working with all partners and stakeholders to successfully implement the actions described in this Plan – and we will need everyone's help to do so.

Mayor Greg Fischer

Executive Summary

Louisville's Greenhouse Gas (GHG) Emissions Reduction Plan (ERP) establishes a framework for achieving the climate action goals that Louisville Metro Government (Louisville Metro) committed to under the Global Covenant of Mayors for Climate & Energy on Earth Day 2016. As the first part of this commitment, Louisville Metro updated its community-wide GHG inventory in 2016 to describe the current sources of GHG emissions generated within its political boundaries. As the second part of the commitment, Louisville Metro joined cities across the globe in setting a target to reduce its community-wide GHG emissions by 80% by 2050. This target was chosen in December 2018 because it aligned with the Paris Agreement and the scientific consensus of what was required to avoid the most damaging effects of climate change at that time.

The ERP builds on a history of past work completed by Louisville Metro to understand the level of GHG emissions generated in our community. In 2005, Louisville Metro joined the U.S. Mayors Climate Protection Agreement. In 2008, Louisville Metro completed Louisville's first GHG inventory based on the 2006 calendar year. In 2018, Louisville Metro released an updated inventory based on the 2016 calendar year. This updated inventory estimates that Louisville generates 16,000,537 tonnes of carbon dioxide equivalent (tCO_2e) per year. Without making any changes, we can expect to see emissions rise to 18,766,066 by the year 2050. If Louisville is successful in reducing emissions by 80% by 2050, remaining GHG emissions will be 3,383,063 tCO_2e (Table E1).

Table E1. Summary of Louisville Metro's GHG Emissions and GHG Reduction Targets

2016 Baseline	2050 Business as Usual	2035 Interim Target	2050 80% Reduction Target
16,000,537 tCO_2e	18,766,066 tCO_2e	12,612,255 tCO_2e	3,383,063 tCO_2e

In addition to setting the target, the ERP communicates strategies that will set Louisville on a path to achieve it. New or improved technologies, continued population growth, regulatory changes, and our connection and relationship with the global economy will drive change in our community. The selected strategies include actions that are already successful in peer cities and reflect our best understanding of where current trends will take us in the years ahead. Although these strategies require significant effort, they align with best practice and are shared with many other communities.

Achieving our reduction goal will require coordinated action from government, businesses, industry, and residents. We identified strategies across six key areas that outline areas of focus for reducing our carbon footprint. These include Residential Buildings, Commercial and Institutional Buildings, Manufacturing Industries and Construction, the Energy Industry, Transportation, and Waste. Strategies include actions that range from administrative policies, incentives, and collaborative partnerships to operational changes and targeted investment in new infrastructure and building technology.

The selection of strategies was informed by input received from key stakeholders, Louisville Metro leaders and internal stakeholders, and from residents through a community survey. Through survey responses, we heard clear messages on which actions were widely supported by the community. The ERP focuses on actions that are broadly supported and actions the community sees as beneficial to improving the quality of life in Louisville. As a forward-looking document, the ERP is intended to be flexible and will be reviewed and updated regularly as a living document.

Introduction

Current Context

The release of carbon dioxide and other greenhouse gases (GHG) is already having an impact on the global climate system. The Fifth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) states the following consensus of scientific opinion about climate change and its causes and effects (IPCC, 2014):

- Warming of the climate system is unequivocal, as is now evident from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice, and rising global average sea level.
- Human-caused GHG emissions have increased since the pre-industrial era, driven largely by economic and population growth, and are now higher than ever. Most of the observed increase in global average temperatures since the mid-20th century is very likely due to the observed increase in human-caused GHG concentrations.
- Continued release of GHG emissions will cause further warming and long-lasting changes in all components of the global climate system, increasing the likelihood of severe, pervasive, and irreversible impacts for people and ecosystems.

The IPCC's 2018 Special Report on Global Warming of 1.5°C is an update to the Fifth Assessment and adds that human activities are estimated to have caused approximately 1.0°C of global warming above pre-industrial levels, with a likely range of 0.8°C to 1.2°C. The report also states that global warming is likely to reach 1.5°C between 2030 and 2052 if it continues to increase at the current rate.

Cities play a critical role in advancing climate action. As centers of communication, commerce, and culture, cities are a major and growing source of energy consumption and therefore GHG emissions. Cities account for more than 70% of global GHG emissions[1], and consequently represent the single greatest opportunity for tackling the challenges of climate change.

Global Covenant of Mayors Commitment

In recognition of the overwhelming influence that cities have over global emissions trends, cities across the world have banded together to take action at the local level, irrespective of regional, state, provincial, and federal level policy. The Global Covenant of Mayors for Climate and Energy (formerly the Compact of Mayors) is a global coalition of cities and their leaders founded by the United Nations Secretary General and the former Mayor of New York City, Michael Bloomberg. The Global Covenant of Mayors represents a united common effort from global organizations and cities to address climate change, with commitments from more than 400 cities.

On Earth Day 2016, on behalf of Louisville Metro, Mayor Fischer signed the Global Covenant of Mayors, agreeing through this commitment to set a science-based target to reduce community-scale emissions in line with the Paris Agreement. In this Emissions Reduction Plan (ERP), we established a blueprint to achieve an 80% reduction in our community-wide GHG emissions by the year 2050.

[1] C40 Cities (2012). Why cities? Ending climate change begins in the city. https://www.c40.org/ending-climate-change-begins-in-the-city

Over the past three years, Louisville Metro has worked to complete the following actions to comply with our Global Covenant of Mayors commitment:

1. Preparation of an updated carbon inventory for emissions originating in Louisville Metro;
2. Establishment of a science-based target; and
3. Identification of actions that will enable achieving this science-based target.

This ERP summarizes the actions that were identified that will set Louisville on a path toward reaching its 2050 emissions reduction target. The proposed actions are based on today's existing technologies. New actions will likely become possible in the future with the introduction of new technology and some actions may see better than expected results as technology improves. Full information on the latest carbon inventory that was created for Louisville Metro can be found in the report entitled the Louisville 2016 Community Greenhouse Gas Emissions Inventory Report dated June 2018.

Co-Benefits of Climate Action

Acting to reduce GHGs can often provide multiple social, environmental, and economic benefits beyond simply reducing contributions of these gases to the atmosphere. Investing in efforts to reduce or eliminate GHGs will benefit Louisville residents through cleaner air, increased options for mobility arising from more dense and walkable neighborhoods, and financial savings from reduced energy operating costs, among other benefits. Some of the co-benefits of GHG reduction are outlined below.

Public Health Impacts - GHG emissions are typically generated in combination with air pollutants (e.g., sulfur dioxide, nitrous oxide, volatile organic compounds, particulate matter, etc.) from sources of combustion. Common sources of air pollutants and GHGs include tailpipe emissions from our vehicles and smokestack emissions from fossil fuel power plants and manufacturing facilities. Reducing emissions from these sources will also directly reduce the quantity of air pollutants in the air that we breathe.

Exposure to outdoor air pollution has been linked to a variety of heart and respiratory diseases and was recently classified as a human carcinogen by the International Agency for Research on Cancer. By reducing GHGs and air pollutants, fewer vulnerable residents will suffer health impacts including asthma, bronchitis, and cardiovascular diseases. This will indirectly lead to fewer hospital and emergency room admissions and fewer people in Louisville living with chronic respiratory illnesses. Better outdoor air quality will also make it easier for all residents to maintain active lifestyles.

By reducing our reliance on fossil fuel intense energy sources, we can also reduce the likelihood of spills and process waste (coal ash) contamination that can impact our local soils and water sources.

Quality of Life Impacts - How we plan and design our neighborhoods and streets can inadvertently create high volumes of GHG emissions by affecting our individual behavior. Urban sprawl leads to longer commutes and trips to run errands. By focusing on development that is of a higher density than currently experienced across Louisville, we can create neighborhoods that are more walkable, and ones that can support a variety of transportation options. This will reduce the level of traffic that we experience and create new and improved opportunities to walk, bike, and use Transit Authority of River City (TARC) transit services. Denser neighborhoods can support more frequent transit service and a wider network of routes with longer operating hours. Improved transit services will create new opportunities for our residents to access jobs, recreation, and services, improving overall quality of life.

More compact development styles, supported by several goals and policies in Louisville's comprehensive plan, Plan 2040[2], will also create more opportunities for clustering of services with personal residences. This form of development is often called 'mixed-use' development. Mixed-use developments combine residential condominiums and apartments with street front stores and cafes. Daycares, medical services, and grocery stores are often staples of this type of development, making it easy for residents in these areas to complete daily appointments and chores without needing to use their vehicles.

By pursuing higher density development patterns, Louisville Metro will also be better able to preserve and protect green and natural spaces for use as recreational amenities and existing agricultural lands. Areas that are used for hiking, dog-walking, fishing, and other recreational pursuits along with productive farmland will be under less pressure as development is directed toward existing developed urban areas.

Economic Benefits - Investment in technologies to reduce GHG emissions are likely to provide economic benefits to Louisville from opportunities for lower energy costs and increased waste recycling and reuse. Reduced energy costs for Louisville residents and businesses will mean more money for investment in the community, while reduced energy costs for Louisville Metro-owned facilities and buildings will mean lower costs to taxpayers. Fewer waste materials entering the landfill will also mean lower costs for solid waste disposal services.

Achieving GHG reductions will require technological innovations, which will create unique opportunities for Louisville businesses to grow and diversify, creating jobs in the community.

Climate inaction comes at a high cost. *The Economics of Climate Change: The Stern Review*[3] firmly established that "the benefits of strong and early action far outweigh the economic costs of not acting." Using results from economic models, the Stern Review estimated that, without action, the overall costs and risks of climate change will be equivalent to losing at least 5% and potentially as much as 20% of global Gross Domestic Product (GDP) annually. In contrast, the costs of implementing actions to reduce GHG emissions and mitigate the impacts of climate change may be limited to 1% of global GDP annually.

Beyond the ecological and economic costs associated with delayed action on climate change, there are cost savings to be realized through efforts to conserve energy and to use it more efficiently, and economic opportunities available to communities that develop local energy supply and infrastructure. Actions that encourage energy efficiency and conservation, identify opportunities for capturing waste heat energy, and promote implementation of renewable energy will assist Louisville in developing an energy resilient community, in addition to mitigating climate change.

[2] Plan 2040: A Comprehensive Plan for Louisville Metro. https://louisvilleky.gov/government/planning-design/comprehensive-plan

[3] Stern, Nicholas. 2006. The Economics of Climate Change: The Stern Review. Cambridge University Press

2016 Louisville Community GHG Inventory

A GHG inventory[4] was completed for 2016 using the methodology published in the Global Protocol for Community Scale Greenhouse Gas Emissions Inventory (GPC Protocol). The 2016 data was used as a baseline for 2050 target setting. Under the GPC Protocol, GHG emissions are split between Core and Expanded emissions:

- Core emissions are those that Louisville Metro has the greatest opportunity to influence. The Core GHG emissions sources include building energy use, fugitive, energy industries, on-road and off-road transportation, and waste (includes solid waste, composting, and wastewater treatment) (**Figure 1**). The Core emissions will be the focus of the emissions reduction plan and to which Louisville's reduction target will be set. In 2016, the Core GHG emissions were 16,000,537 tonnes of carbon dioxide equivalent (tCO_2e).
- Expanded emissions are the additional sources not included as the Core emissions. They include transboundary transportation, industrial process and product use (IPPU), and agriculture, forestry, and other land-use (AFOLU). These sources typically serve regional and state demands, many have federal regulations and reporting standards, and thus are not as easy for Louisville Metro to influence. The total 2016 GHG emissions (Expanded + Core) were 21,554,911 tCO_2e. Through future GHG inventories, Louisville Metro will continue to monitor trends and identify opportunities where actions can have an impact on reducing the Expanded GHG emissions. Specific reduction targets, or actions, will not be identified for the Expanded GHG emissions.

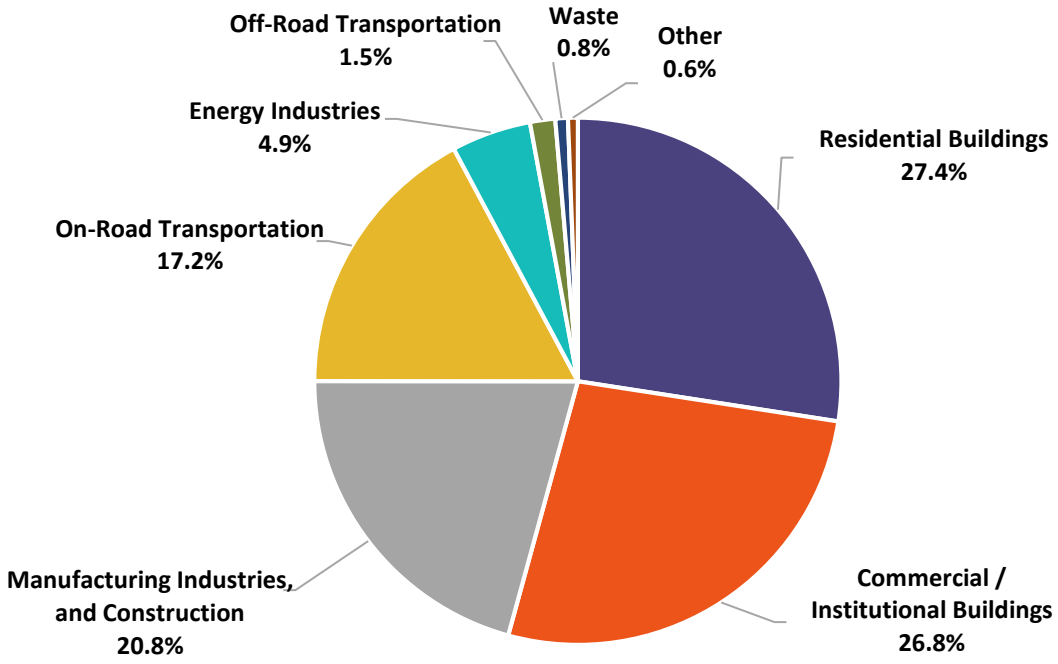


Figure 1. 2016 Core GHG Emissions

[4] Louisville 2016 Community Greenhouse Gas Emissions Inventory Report.
https://louisvilleky.gov/government/sustainability/greenhouse-gas-inventory

GHG Contributions by Sector

The GPC Protocol organizes and aggregates GHG emissions by Sector and Sub-Sector. For example, the Stationary Energy Sector includes a wide range of sub-sectors including residential and commercial buildings, manufacturing and construction activities, fugitive emission sources, energy generation activities, etc. A detailed breakdown of the sectors and subsectors can be found in the inventory report.[5]

Stationary Energy
Approximately 80.5% of Louisville's GHG emissions result from the use of electricity and other fuels like natural gas and propane to heat, cool, and power buildings.

Transportation
About 18.7% of Louisville's GHG emissions comes from using fossil fuels in vehicles including gasoline, diesel, and propane.[6] The inventory includes vehicles registered in Louisville Metro as well as marine and aviation sources.

Waste and Wastewater
A portion of community emissions comes from waste that goes to landfills where it decomposes and releases methane, a potent greenhouse gas. The inventory includes emissions from solid waste, compost, and wastewater generated in Louisville.

Comparing to Other Cities

Louisville's per capita GHG emissions exceed the national average when compared to other US cities that report publicly for the Global Covenant of Mayors, as seen in Table 1. These peer cities are similar to Louisville in size, climate, and geography; however, comparing per capita emissions among cities may be of limited value for many reasons. These include the availability of relevant data, differing calculation methodologies and study area boundaries (e.g., county, city, region) and differences in the cities' economic drivers and energy sources (e.g., hydroelectric, coal, natural gas).

Table 1. Peer City Per Capita Emissions

Per Capita Emissions	
Columbus, OH	13.2 tCO_2e
Austin, TX	15.5 tCO_2e
US National Average	16.5 tCO_2e
Nashville, TN	20.1 tCO_2e
Louisville Metro, KY	20.9 tCO_2e
Knoxville, TN	21.7 tCO_2e
Memphis, TN	22.0 tCO_2e
St. Louis, MO	22.9 tCO_2e

[5] Louisville 2016 Community Greenhouse Gas Emissions Inventory Report. https://louisvilleky.gov/government/sustainability/greenhouse-gas-inventory

[6] In 2016, approximately 97% of the electricity supplied to Louisville was produced by the combustion of fossil fuels, compared to 81% nationally. This difference means that as a percentage of Louisville's total emissions, electricity- related GHG emissions appear relatively high, while other sectors, such as transportation, appear relatively low.

2050 Business-as-Usual Forecast

The Louisville 2016 Community GHG Emissions Inventory provides a summary of how our emissions currently stand in the community. Louisville Metro will not, however, remain static. Our population is expected to increase, which will mean more homes, more jobs, more roads, and therefore, more GHG emissions.

If we assume that very few things about our current way of life will change in the future, we can create a baseline scenario that provides a reference point for us to measure our success or progress against. This type of scenario is called the **Business-as-Usual (BAU) forecast**. To estimate future emissions, we must consider many different variables. Some of the key variables that must be considered include the following:

Population – the number of people that will live in Louisville in 2050

Energy – the energy sources that we will use to heat and power our buildings in 2050

Vehicles – the number and type of vehicles that are likely to travel our roads by 2050

Buildings – the number and size of homes, offices, and other buildings that will exist in 2050

Waste – the volume of waste that we generate from our homes and businesses in 2050

Under our BAU forecast, we assumed that Louisville in 2050 will not experience any significant changes from technology, economics, or public policy, and that the attitudes and behaviors that we currently have will remain unchanged. In other words, under the BAU forecast, Louisville will remain exactly as it is right now – just bigger.

By using this scenario as a baseline for comparison, any decisions that we make between now and 2050 can be measured and compared to the baseline to see what impact the decisions have on our emissions. As an example, if our commercial buildings install more solar energy panels, that will register as a difference from the BAU scenario, and we can measure the impact of this change on our GHG emissions.

BAU Forecast Assumptions

To create our BAU forecast, we used a broad range of assumptions to estimate conditions in Louisville in 2050 (**Table 2**). The population of Louisville is expected to rise by almost 150,000. Increases in housing stock and vehicle ownership are triggered to accommodate these new residents. The types of energy sources that are used are shown to remain consistent under the BAU scenario, with most electricity being supplied from fossil fuel power plants.

Using these assumptions, GHG emissions in Louisville in 2050 are estimated to be 18,766,066 tCO_2e, or 20.5 tCO_2e per person. As a prediction of the future, the BAU scenario must be considered an estimate, as it is very likely many of the assumptions will change over time. This information represents the best knowledge and data that is available today.

Table 2. Summary of Current and BAU Parameters

Parameter	Current Reality	2050 BAU Assumption
Population	768,900	913,221
Number of Homes	344,657	395,834
Number of Vehicles	554,050	658,043
Electricity Grid Emissions Intensity	0.84 tCO_2e/MWh	0.84 tCO_2e/MWh
Transmission Line Loss Factor	4.02%	4.02%
Natural Gas Emission Factor	0.05 tCO_2e/GJ	0.05 tCO_2e/GJ

Louisville Metro GHG Reduction Target

In line with our commitment to the Global Covenant of Mayors, Louisville Metro established a GHG reduction target of 80% below BAU scenario levels by 2050. This will be accomplished through strategies and actions implemented across six key sectors[7]:

- **Residential Buildings** – our homes, apartments, and condominiums
- **Commercial and Institutional Buildings** – our offices and our civic buildings
- **Manufacturing Industries and Construction** – our industries and new construction
- **Energy Industry** – our energy providers who use various fuel sources to create electricity
- **Transportation** – our vehicles, our road networks, and our transit
- **Waste** – our solid waste and wastewater treatment systems and infrastructure

Strategies and actions included in the ERP were derived from best practices demonstrated by cities across the globe working to reduce their GHG emissions. Through meetings with key stakeholders and Louisville Metro leadership as well as a community survey, the final suite of strategies and actions includes those with the most support and those that we are most likely able to accomplish. Strategies and actions also reflect current market forces, such as increases in the number of electric vehicles and in the production of electricity from solar power. **Table 3** highlights the most popular items in the community survey. Full results from the community survey can be found in Appendix D.

Table 3. Summary of Survey Results

Action/Strategy	Support
Buy energy efficient appliances	87%
Support discounts for TARC riders	81%
Support incentivizing solar panels	79%
Support providing additional curbside recycling options	79%
Adjust your thermostat	78%
Buy a programmable thermostat	74%
Support incentivizing carpooling	74%
Support incentivizing hybrid and electric vehicles	69%

Louisville Metro also set an interim target of achieving a 26% reduction over the BAU scenario by 2035. **Figure 2** demonstrates the estimated 2016 baseline inventory and the estimated remaining emissions from the 2035 interim target and the 2050 80% reduction target. The interim target will enable us to assess whether we are on the right track toward meeting our 80% by 2050 reduction target.

While 2035 is roughly halfway to 2050, the 2035 target is considerably less than a 40% reduction. This difference is mainly due to the expectation that significant changes in how Louisville Gas and Electric (LG&E) produces electricity will not occur until after 2040. Reducing the carbon intensity factor of energy generation is the most impactful strategy and will result in large emissions reductions in the residential, commercial, and manufacturing sectors. If LG&E were to retire their coal fired power plants earlier or make a significant switch to more renewable energy sources, we could see a larger reduction at an earlier date.

[7] For organizational purposes, four sub-sectors from the Energy Sector are separated out and referred to as sectors in this plan. They do not exactly match GPC sectors.

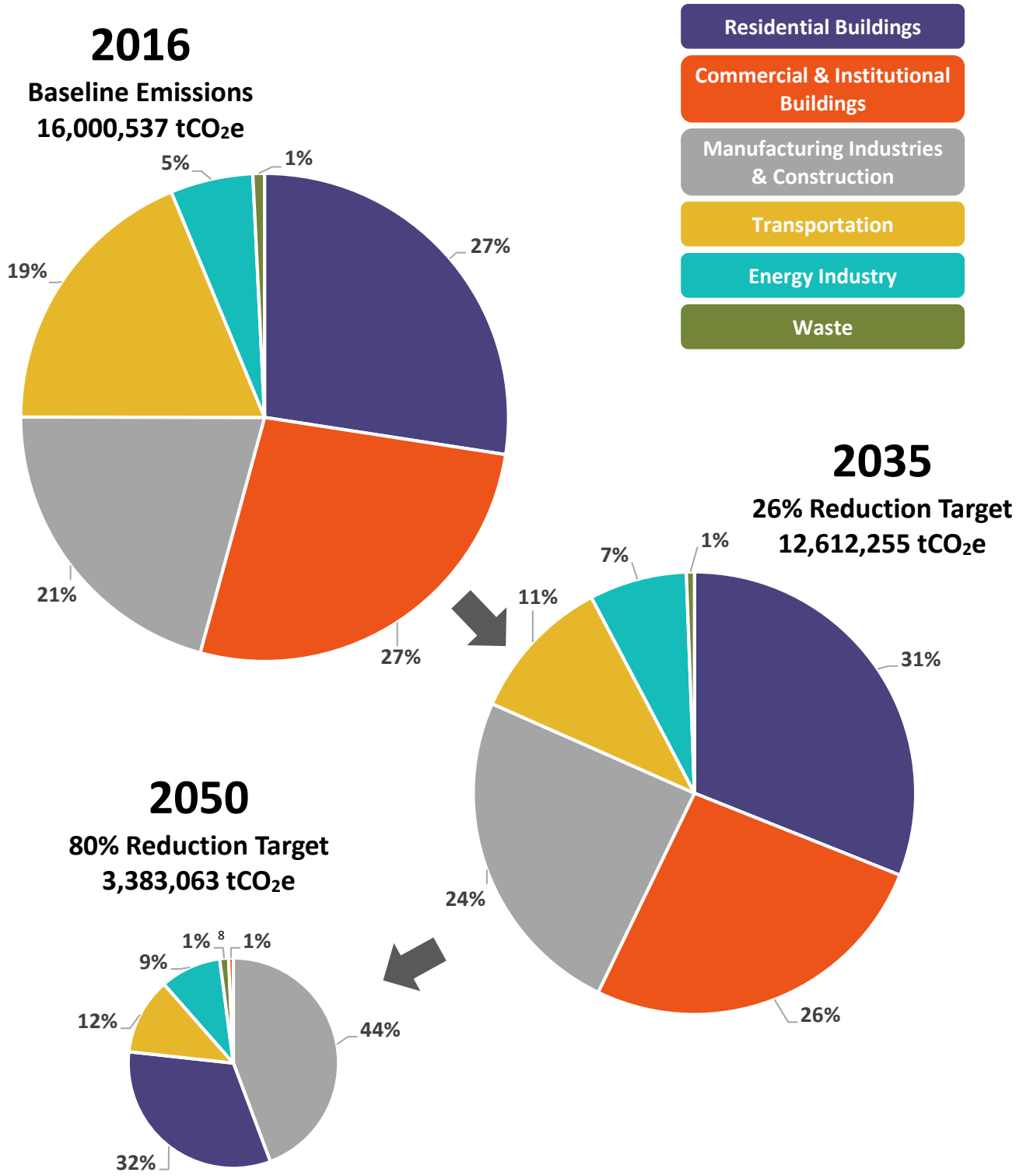


Figure 2. Baseline, 2035 and 2050 GHG Emission Profiles

[8] By 2050, the commercial sector is expected to contribute less than 1% to the total GHG emissions due to the combination of efficiency gains from retrofits, commissioning, building code improvements, and the competition of benchmarking, as well as additional renewable natural gas and the cleaning of the electricity grid. The estimated solar potential from rooftops is expected to offset the remaining emissions, assuming Louisville Metro is successful at reaching the targets described in Table 4.

How We Will Reach Our Targets

Table 4 presents a summary of potential strategies identified to enable achieving the 80% reduction target. Different sectors are expected to contribute different levels of GHG emissions reductions. This is reflective of the contribution of these sectors to overall Louisville emissions, and is also reflective of the relative level of opportunity to achieve emissions reductions. This table illustrates the importance of LG&E transitioning to cleaner energy generation in meeting the overall 80% reduction target and how, based on electricity use, that transition will impact reductions in the residential, commercial, and manufacturing sectors. Strategy E-1, 70% Energy Generation Intensity Factor Reduction, is split between the residential, commercial, manufacturing, and energy industry sectors because GHG emissions from energy are reported based on where the energy is consumed.

Louisville Metro recognizes the meaningful contributions trees make to GHG emissions reduction and will continue to support a variety of strategies designed to increase our tree canopy. These strategies, however, are not included in the ERP because they fall within the Expanded, rather than the Core Emissions, which are the focus of the ERP.

Concurrent with the development of this ERP, Louisville Metro Council passed a resolution to support (1) a 100% clean renewable electricity goal for Metro Government operations by 2030, a 100% clean energy goal for Metro Government operations by 2035, and a 100% clean energy goal community-wide by 2040; and (2) the revision of all building codes for new construction to require energy efficiency, conservation, and renewable energy applications toward an eventual goal of net zero or net positive energy, water, and waste for Louisville Metro. Adoption of this resolution (Appendix E) is expected to provide additional support for implementing strategies and actions across all sectors in this ERP. If successful, the resolution has the potential to propel Louisville beyond the 80% by 2050 reduction target.

Table 4. Potential GHG Reduction Strategies[9]

	Estimated 2035 Reductions tCO_2e/yr.	Estimated 2050 Reductions tCO_2e/yr.
R – RESIDENTIAL BUILDINGS	**977,608 5.2%**	**4,115,256 21.9%**
R-1. Energy Efficiency through Updated Building Code	88,530	139,784
R-2. Existing Residential Building Retrofits	631,826	997,620
R-3. Solar PV Systems on 50% of Homes	156,458	247,039
R-4. Renewable Natural Gas in 20% of Homes	100,794	159,149
E-1. 70% Energy Generation Intensity Factor Reduction	0	2,571,665
C – COMMERCIAL/INSTITUTIONAL BUILDINGS	**1,345,545 7.2%**	**4,956,943 26.4%**
C-1. Energy Efficiency through Updated Building Code & Commissioning	54,201	85,580
C-2. Existing Commercial & Institutional Building Retrofits	445,360	703,200
C-3. Solar PV on 25% of Commercial & Institutional Buildings	634,672	1,002,113
C-4. Renewable Natural Gas in 20% of Commercial Buildings	50,396	79,573
C-5. Building Energy Benchmarking Program	160,917	254,079
E-1. 70% Energy Generation Intensity Factor Reduction	0	2,832,398
M – MANUFACTURING INDUSTRIES AND CONSTRUCTION	**543,260 2.9%**	**2,382,649 12.7%**
M-1. Existing Manufacturing Facility Retrofits	283,689	447,930
M-2. Combined Heat and Power Facility	14,567	23,000
M-3. Building Energy Benchmarking Program	72,909	115,119
M-4. Renewable Natural Gas in 50% of Manufacturing Facilities	150,460	237,569
M-5. Fuel Switch from Combustion of Coal to Natural Gas	21,636	34,162
E-1. 70% Energy Generation Intensity Factor Reduction	0	1,524,870
E – ENERGY INDUSTRY	**46,483 0.2%**	**697,517 3.7%**
E-1. 70% Energy Generation Intensity Factor Reduction	0	624,122
E-2. Demand Side Management Program	35,814	56,549
E-3. LEDs in Lighting Fixtures and Streetlights	10,669	16,846
T – TRANSPORTATION	**1,986,249 10.6%**	**3,136,182 16.7%**
T-1. Increased Densification	316,362	499,519
T-2. Active Transportation and Ridesharing	496,113	783,336
T-3. Improved Transportation Systems	728,659	1,150,515
T-4. Fuel Switching (50% of passenger trips electrified)	445,115	702,813
W – WASTE	**59,823 0.3%**	**94,457 0.5%**
W-1. Organic Waste Diversion Programs	23,545	37,177
W-2. Methane Recovery from Wastewater Treatment Plants	1,086	1,714
W-3. Methane Recovery at Landfills	35,192	55,566
Total Emissions Reduced	***26.4%***	***82.0%***

[9] Percentages listed in this table represent each sector's contribution to the total reduction from projected 2050 business-as-usual GHG emissions. Values for individual strategies represent estimated reduction potential (tCO_2e). Values will not add up to the exact amount of emissions reduction needed to reach Metro's targets because estimated reduction amounts are based on the potential impact of the individual strategies and are not a simple percentage of the target or BAU.

How to Use This Plan

The GHG emissions reduction strategies on the following pages are organized by Sector. Each section begins with a brief description of the Sector, an explanation of the Sector's potential contribution to the GHG emission reduction target, and a summary of co-benefits that should also result from completion of the Sector's strategies and actions. Unless otherwise noted, assumptions related to the reduction potential of the individual strategies are based on guidance for quantifying project level mitigation of GHG emissions published by the California Air Pollution Control Officers Association.[10] Each strategy includes a description and tables that break down the logistics and solutions associated with achieving the GHG reductions being sought.

Logistics

Timeline	Estimated Cost	Responsibility	Tracking Metrics
Designates a short-, medium-, or long-term timeline for when the strategies will be implemented. Some strategies may be designated as long-term based on when the outcomes will produce significant change but include actions that are underway or may begin in the near future.	Presents a preliminary estimate for the potential cost of implementation. Low cost strategies typically involve policy and behavior changes, while high cost strategies typically include large investments in technology or equipment.	Suggests a lead agency to guide implementation of each strategy and identifies key partners that will play important roles in implementing specific actions.	Offers metrics to aid in tracking and evaluating performance of the strategies.

Solutions

Financing/Policy Strategy	Implementation Actions	Status
Designates a category for the type of implementation the actions will require. **Local Solutions - with funding needs** are actions that will require a financial commitment by Louisville Metro and/or participating agencies, business, and residents**. Local Solutions - without funding needs** are actions that do not require a financial commitment by Louisville Metro. **State Solutions** are actions that require policy changes or legislation at the state level.	Presents actions that will support implementation of the strategy with a status designation of Completed, Underway, Planned, or Proposed. Planned actions are those that closely match actions or policies from previously adopted Louisville Metro planning efforts. Proposed actions are new and unique to this plan.	Where appropriate, provides details for actions that are complete, underway, or planned.

[10] Quantifying Greenhouse Gas Mitigation Measures: A Resource for Local Government to Assess Emission Reductions from Greenhouse Gas Mitigation Measures. http://www.capcoa.org/wp-content/uploads/2010/11/CAPCOA-Quantification-Report-9-14-Final.pdf

Residential Buildings

Residential buildings emissions are generated from the use of energy in our homes through fuel combustion (e.g., burning wood in fireplaces or woodstoves, natural gas used for heating and cooking, etc.) and by the consumption of electricity for heating and cooling, lighting, and powering our electronic devices. In 2016, residential building emissions accounted for approximately 27.4% of total emissions generated in Louisville (**Figure 3**).

Potential Contribution to Overall Reduction Target

The electricity that we use in our homes is one of the most significant contributors to emissions and it is one of the hardest emissions sources to address. Making progress on reducing GHG emissions from existing residential properties will require a more efficient building code, and education and outreach to assist homeowners to individually make choices that will improve the energy efficiency of their homes. Typical measurements to take include improving insulation, replacing outdated appliances with energy-efficient models, upgrading windows and door frames, and installing renewable energy sources. Active measures that Louisville Metro can take to reduce residential buildings emissions could accomplish approximately 26.8% of the reduction required to achieve our 80% reduction by 2050 commitment.

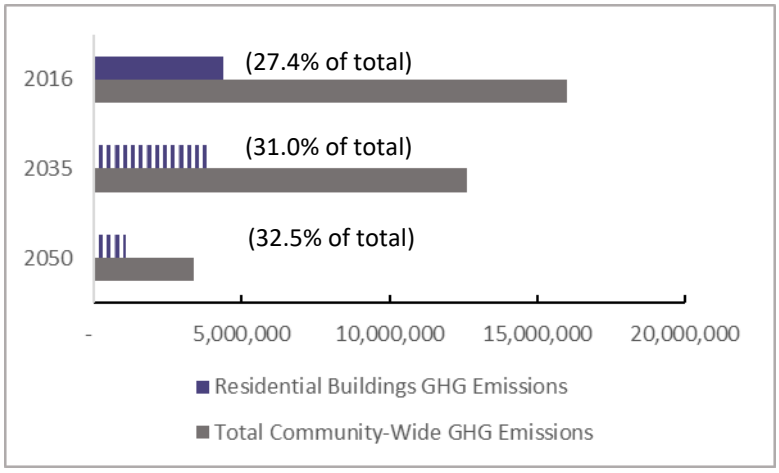


Figure 3. GHG Contributions by Residential Building Sector

Co-Benefits

In addition to lower emissions, energy costs will decrease for residential households that implement energy-efficient upgrades, which can benefit lower income households that experience disproportionate energy burdens. Reduced demand for electricity will decrease the burden on our fossil fueled power plants, which will improve local air quality and therefore public health.

R-1. Energy Efficiency through Updated Building Code

Description

Raising energy efficiency standards for new buildings is a straightforward, cost efficient way to reduce emissions over the long-term. Requiring new buildings to be constructed to meet high standards for energy efficiency will avoid the need for expensive and disruptive retrofits later to meet the emissions reduction requirements. Developers could benefit from the use of existing rating or certification systems such as Leadership in Energy and Environmental Design (LEED) or ENERGY STAR, which provide guidance and best practices on how to successfully adopt higher standards for efficiency in new buildings.

The construction and renovation of buildings is currently regulated by the Commonwealth of Kentucky Building Code and is outside of Louisville Metro's jurisdiction. Kentucky currently enforces the 2009 and 2012 International Energy Conservation Codes. This strategy assumes the introduction of more stringent requirements for energy conservation in residential buildings through changes to the Kentucky Building Code or through incentives for 'beyond-code' energy efficiency and performance in new construction. Updating the building code may require the Mayor and Metro Council to advocate for legislation that adopts the most recent International Building Code or that allows local governments to make their own improvements.

Many other states have already implemented Building Code energy standards that are more stringent than those required in Kentucky. This strategy therefore does not represent an unproven or high-risk approach, as simply matching requirements already adopted by other states will provide significant emissions reduction benefits. Actions taken to update Building Code requirements will lead to improvements in energy performance and reductions in the consumption of electricity and natural gas in future residential buildings constructed in Louisville. Improving building standards for residential buildings could offer the potential for a cumulative avoidance of 139,784 tCO_2e by 2050, representing a 0.75% reduction in emissions over the BAU scenario.

Residential Buildings

R-1 Logistics

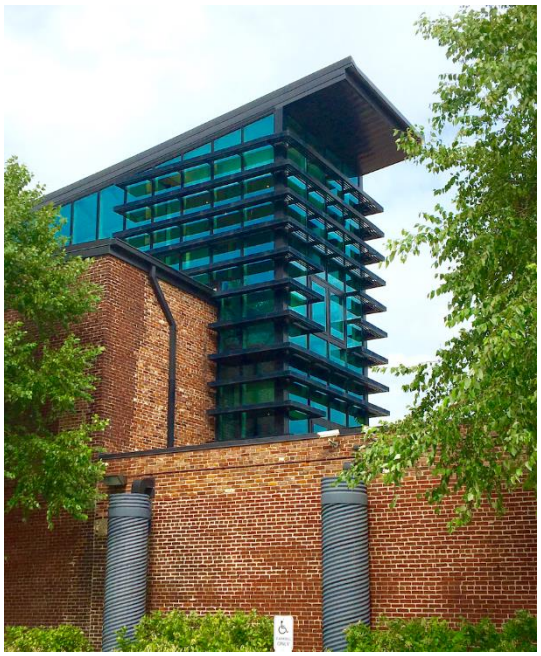
Timeline	Estimated Cost	Responsibility	Tracking Metrics
Medium Term	Moderate direct cost to Louisville Metro in the form of financial incentives and development bonuses offered to developers. Potential for cost savings from more efficient service delivery in denser neighborhoods.	Lead Agency: Mayor's Office Key Partners: Develop Louisville, Louisville Metro Codes & Regulations, Louisville Energy Alliance, Building Industry Association of Louisville, Greater Louisville, Inc.	• Building Design Metrics (e.g., building envelope is improved such that air infiltration is reduced by 25% relative to a code-compliant envelope) • Building Code standards for envelope, lighting, HVAC, service water heating, and electric power systems and motors • Energy Performance • Energy consumption per square foot

R-1 Solutions

Financing/Policy Strategy	Implementation Actions	Status
Local Solutions - with funding needs	• Provide financial incentives to residential property developers that voluntarily commit to meeting energy performance requirements that exceed the current Building Code • Develop and implement a pilot residential energy labeling program at time of sale for residential homes - ENERGY STAR certified homes program • Offer density bonuses to developers which allow denser development than normally permitted in exchange for providing public housing	• No actions currently underway
Local Solutions - without funding needs	• Implement urban planning and zoning requirements that promote higher-density development, which can decrease residential building energy demand • Encourage the adoption of LEDs in existing and new homes for more efficient lighting • Lobby for improvements to the Kentucky Building Code and associated requirements for energy performance for new residential buildings	• Louisville Metro's Plan 2040 Comprehensive Plan includes several goals and policies supporting higher-density and more sustainable development.
State Solutions	• Adopt improvements to the Kentucky Building Code and associated requirements for energy performance for new residential buildings	• No actions currently underway

R-2. Existing Residential Building Retrofits

Description



Deep energy retrofits can achieve reductions in energy consumption of 50% or greater through whole-building analyses and retrofits of multiple building systems at the same time. Common strategies to achieve deep energy retrofits include making improvements to the building exterior (e.g., insulation, air sealing) coupled with upgrades to heating, cooling, lighting, and hot water systems. This will be a medium to long-term strategy as it will require education and outreach, followed by investment by Louisville residents.

Louisville Metro can promote and incentivize building owners to investigate and implement energy conservation measures and upgrades within their homes. Louisville Metro should start small and cap any incentive / grant program at a limited number of applicants to test the interest in the community without committing to a large grant program. This will help to focus investment on incentive programs that will provide the best return on investment. Incentive programs are often under-subscribed and will require investment in promotion and marketing to increase awareness within the community.

Completing retrofits of existing residential buildings could offer the potential for a cumulative avoidance of 997,620 tCO_2e by 2050, representing a 5.3% reduction in emissions over the BAU scenario.

R-2 Logistics

Timeline	Estimated Cost	Responsibility	Tracking Metrics
Medium-Long-Term	Moderate direct cost to Louisville Metro for completion of studies and to support rebate and incentive programs.	Lead Agency: Develop Louisville Key Partners: Building Industry Association of Louisville, Louisville Energy Alliance, Interfaith Power and Light, Project Warm, LG&E	• Annual energy consumption (kWh, GJ) • Participation in incentive programs (number of households reached) • Annual investment level in incentives programs ($) • Energy and/or carbon reductions achieved per $ invested

Residential Buildings

R-2 Solutions

Financing/Policy Strategy	Implementation Actions	Status
Local Solutions - with funding needs	• Continue to support and promote education and incentive programs that encourage energy conservation and efficiency by Louisville residents • Support low-income residential building weatherization programs • Free building inspections for home energy retrofits that attain current Kentucky Building Code energy performance standards or better • Building permit fee rebates for home energy retrofits that attain current Kentucky Building Code energy performance standards or better and waiving of building permit fees for home energy retrofits that exceed the energy performance standards required in the Code • Commission a study of condominium and non-market rental housing retrofits to identify strategies on how to revitalize and regenerate existing rental housing stock while preserving affordability and improving energy performance • Install building automation and controls such as adaptive thermostats, lighting sensors, and plug load monitors	• Louisville Metro's Weatherization Assistance Program (WAP) enables low-income families to reduce their energy bills by making their homes more energy efficient. • Project Warm provides free energy conservation services and education, to promote energy saving practices in the community.
Local Solutions - without funding needs	• Study existing incentive programs used by comparable communities to inform the creation of incentives programs for our community that will provide best value • Require the consideration of renewable and alternative energy in the planning and design of retrofits of existing buildings to enable low-cost future installation • Share information on existing and planned programs and incentives for home energy audits and retrofits through a marketing campaign and on Louisville Metro's website to increase awareness about programs • Support establishment of a Green Bank[11] or other efficiency loan program with specific programs for low-income residents	• No actions currently underway
State Solutions	• Expand Energy Project Assessment District[12] (EPAD) program to include single-family residential properties.	• No actions currently underway

[11] A Green Bank is a public, quasi-public or non-profit entity established specifically to facilitate private investment into domestic low-carbon, climate-resilient infrastructure. https://greenbanknetwork.org/

[12] Louisville's Energy Project Assessment District (EPAD) program is a tool that allows property owners to repay private loans for energy efficiency, renewable energy and water conservation measures through a voluntary assessment administered by the Jefferson County Sheriff in the same manner as a property tax bill. https://louisvilleky.gov/government/sustainability/epad-program

R-3. Solar PV Systems on 50% of Homes

Description

Residential-scale solar energy is a proven technology that has experienced significant price decreases in recent years for installation and maintenance. It is expected that solar energy will provide a compelling business case for homeowners in future years, which will incentivize installation across Louisville.

Louisville Metro can continue to create the conditions to promote increased installation of solar panels on residential homes. This will increase the availability of renewable energy for homeowners, reducing their reliance on the electricity grid and offsetting emissions associated with grid-based electricity generation, transmission, and consumption. In 2017, Louisville Metro was awarded a gold designation by SolSmart, a program funded by the U.S. Department of Energy. This designation recognizes Louisville Metro's efforts to create a supportive environment for solar installation by reducing red tape and barriers to consumer adoption of solar energy.

Increased adoption and installation of rooftop solar power generation has the potential to achieve a cumulative avoidance of 247,039 tCO_2e by 2050, representing a 1.3% reduction in emissions over the BAU scenario.

R-3 Logistics

Timeline	Estimated Cost	Responsibility	Tracking Metrics
Short- to Long-Term	High direct costs to residents from installation of new solar capacity. Upfront costs offset by reduced energy costs over lifespan of solar panels[13].	Lead Agency: Develop Louisville Key Partners: Solar Over Louisville, LG&E, Louisville Energy Alliance, Louisville Sustainability Council, Green Building Council, 100% REAL, local solar installers	• Solar generation capacity for residential properties (MW)

[13] In 2019, Kentucky passed new legislation (Senate Bill 100) that will lower the amount of savings solar customers will receive from their solar panel systems. Electric suppliers will now compensate customers for all their electricity produced at rate set by the Public Service Commission instead of the retail rate of electricity. https://www.solar-estimate.org/news/kentucky-net-metering-changes-to-affect-solar-customers

Residential Buildings

R-3 Solutions

Financing/Policy Strategy	Implementation Actions	Status
Local Solutions - with funding needs	• Louisville Metro will lead by example through installation of solar panels on public buildings • Develop and publicize local financing options such as leasing panels from local solar installers to help reduce up-front installation costs	• No actions currently underway
Local Solutions - without funding needs	• Expedite permitting processes for solar installations • Require the consideration of renewable and alternative energy in the planning and design of new buildings to enable low-cost future installation • Eliminate barriers by reducing building permit fees • Advocate for a feed-in tariff or net metering program which would promote energy security while supporting the business case for adoption of renewable energy locally • Implement clear zoning regulations that permit solar energy installations on residential rooftops • Ensure codes and ordinances in Louisville Metro allow homeowners to generate electricity from sunlight that shines on their property, including in historic districts • Require new homes to install solar power or be designed to be 'solar-ready'	• Louisville Metro streamlined permitting for residential rooftop and ground mount systems
State Solutions	• Adopt stronger state financial incentives for solar energy, ambitious renewable electricity standards, and comprehensive solar rights policies • Adopt an increasing-over-time Renewable Energy Portfolio Standard to drive increasing investments in renewable energy for all sectors • Expand and improve the net metering policy by increasing the net metering limit to at least 1000 kW[14] and lifting the cap to at least 8% of peak demand • Expand Energy Project Assessment District[15] (EPAD) program to include single-family residential properties.	• No actions currently underway

[14] Senate Bill 100 increased the size of renewable energy systems that qualify for net metering from 30 kilowatts (kW) to 45 kW. https://www.solar-estimate.org/news/kentucky-net-metering-changes-to-affect-solar-customers

[15] Louisville's Energy Project Assessment District (EPAD) program is a tool that allows property owners to repay private loans for energy efficiency, renewable energy and water conservation measures through a voluntary assessment administered by the Jefferson County Sheriff in the same manner as a property tax bill. https://louisvilleky.gov/government/sustainability/epad-program

R-4. Renewable Natural Gas in 20% of Homes

Description

Renewable Natural Gas (RNG) is natural gas that is derived from organic waste material sources such as food waste, garden and lawn clippings, animal waste, paper, cardboard, wood, and solid waste. Common facilities that produce RNG include wastewater treatment plants (WWTP) and landfills. The local abundance of these materials provides potential for vast quantities of biogas to be produced.

RNG provides carbon emissions reductions in comparison to traditional natural gas as it avoids emissions associated with gas extraction, refining, transportation, and storage. RNG also enables the capture of greenhouse gas emissions such as methane from landfill gas for beneficial reuse as a heating source. Increased use of renewable natural gas could offer the potential for a cumulative avoidance of 159,149 tCO_2e by 2050, representing a 0.85% reduction in emissions over the BAU scenario.

R-4 Logistics

Timeline	Estimated Cost	Responsibility	Tracking Metrics
Medium-Long-Term	Low direct cost to Louisville Metro, moderate to high cost to RNG providers	Lead Agency: Public Works Key Partners: Waste Management, Rumpke, Eco-Tech, MSD, LG&E	• Volume of RNG produced or sold annually (GJ)

R-4 Solutions

Financing/Policy Strategy	Implementation Actions	Status
Local Solutions - with funding needs	• Support efforts to build infrastructure to capture and clean biogas from WWTP and landfills • Complete a market analysis of renewable natural gas opportunities accessible to Louisville Metro and rationale for investment • Provide residents with incentives to use biogas for their energy needs	• Waste Management of Kentucky began capturing natural gas at the Outer Loop Recycling and Disposal Facility in June 2018 • Rumpke has plans to begin construction of a methane capture system at their Medora landfill in 2020
Local Solutions - without funding needs	• Use existing pipelines to deliver renewable gas to homes • Support programs to collect increased volumes of biogas and other renewable sources for increased use of RNG in the community • Allow excess heat and electricity generated by the RNG production process to be sold back to electric companies • Introduce a new policy to provide a framework for the purchase and delivery of RNG to residential customers for space and water heating	• Natural gas captured at the Outer Loop Recycling and Disposal Facility is sold at a vehicle fueling station and to LG&E for their natural gas delivery system
State Solutions	• Pass legislation that funds a study to identify the technical, financial, and environmental potential of RNG in Kentucky[16]	• No actions currently underway

[16] The California Air Resources Board and the California Environmental Protection Agency commissioned a feasibility study examining the potential of renewable natural gas in California. https://steps.ucdavis.edu/wp-content/uploads/2017/05/2016-UCD-ITS-RR-16-20.pdf

Commercial & Institutional Buildings

Commercial and institutional (e.g., schools, hospitals, libraries, government) building emissions arise from the combustion of fossil fuels including coal and natural gas to provide heating and cooling as well as from electricity consumed by the activities that occur within these office buildings and facilities. In 2016, commercial and institutional building emissions accounted for approximately 26.8% of total emissions generated in Louisville (**Figure 4**).

Potential Contribution to Overall Reduction Target

Beyond anticipated improvements in energy efficiency, active measures that Louisville Metro could take to reduce commercial and industrial buildings emissions would accomplish approximately 9.5% of the reduction required to achieve the 80% by 2050 commitment. The combination of the five strategies outlined in this sector, plus the cleaning of the electricity grid outlined in E-1, has the potential to remove most of Louisville's commercial and institutional building emissions. The difference in the potential reductions relative to residential buildings is largely due to the significant amount of commercial rooftop area available to place solar arrays.

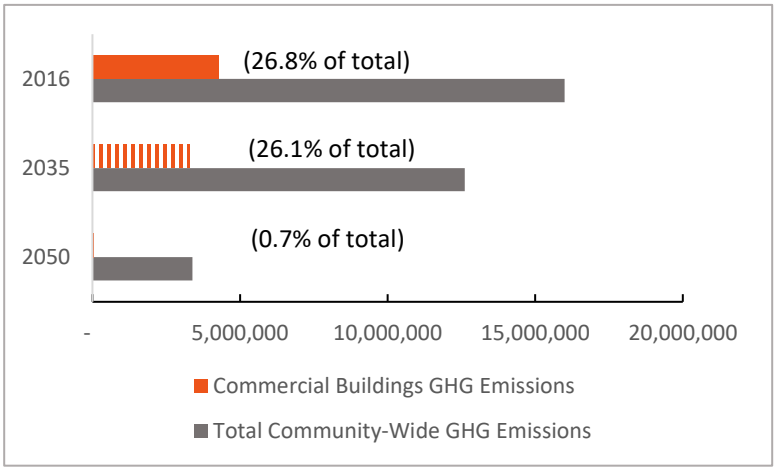


Figure 4. GHG Contributions by Commercial & Institutional Buildings Sector

Co-Benefits

There are other benefits to creating more energy efficient commercial and institutional buildings beyond lowering emissions. Lower energy use can reduce the costs to end users, and can also decrease the burden on power plants, which can improve local air quality.

C-1. Energy Efficiency through Updated Building Code and Commissioning

Description

Raising energy efficiency standards for new buildings is a simple, cost efficient way to reduce emissions over the long-term. Requiring new buildings to be constructed to meet high standards for energy efficiency will avoid the need for expensive and disruptive retrofits later to meet the emissions reduction requirements. Developers could benefit from the use of existing rating or certification systems such as LEED or ENERGY STAR, which provide guidance and best practices on how to successfully adopt higher standards for efficiency in new buildings. Additionally, the commissioning process tests new building systems (heating, cooling, ventilation, hot water) and helps to ensure they are performing optimally and at maximum efficiency.

The construction and renovation of buildings is currently regulated by the Commonwealth of Kentucky Building Code and updating the code to the most recent standards is not within Louisville Metro's authority. This strategy assumes the introduction of more stringent requirements for energy conservation within institutional and commercial buildings through changes to the Kentucky Building Code or through incentives for 'beyond-code' energy efficiency and performance. Actions taken to update Building Code requirements will lead to improvements in energy performance and reductions in the consumption of electricity and natural gas in future commercial and institutional buildings constructed in Louisville. Updating the building code may require the Mayor and Metro Council to advocate for legislation that adopts the most recent International Building Code or that allows local governments to make their own improvements.

Improving building standards for commercial and institutional buildings could offer the potential for a cumulative avoidance of 85,580 tCO_2e by 2050, representing a 0.46% reduction in emissions over the BAU scenario.

C-1 Logistics

Timeline	Estimated Cost	Responsibility	Tracking Metrics
Medium-Term	Moderate direct cost to Louisville Metro in the form of financial incentives and development bonuses offered to developers. Potential for cost savings from more efficient service delivery in denser neighborhoods.	Lead Agency: Mayor's Office Key Partners: Develop Louisville, Building Industry Association of Louisville, Greater Louisville, Inc., Louisville Energy Alliance, Green Building Council, Louisville Metro Codes & Regulations	• Design Metrics • Building Code standards for envelope, lighting, HVAC, service water heating, and electric power systems and motors • Energy performance • Energy consumption per square foot

Commercial & Institutional Buildings

C-1 Solutions

Financing/Policy Strategy	Implementation Actions	Status
Local Solutions - with funding needs	• Provide financial incentives to institutional and commercial property developers that voluntarily commit to meeting energy performance requirements that exceed the current Building Code • Offer density bonuses to developers which allow denser development than normally permitted	• Louisville's Energy Project Assessment District (EPAD) program allows property owners to repay private loans for energy efficiency, renewable energy and water conservation measures.
Local Solutions - without funding needs	• Encourage the adoption of LEDs in existing and new commercial buildings for more efficient lighting • Implement urban planning and zoning requirements that promote higher-density development, which can decrease commercial building energy demand • Require commissioning of all new commercial and institutional buildings • Leverage negotiating power (through Louisville Metro's size as a customer) to lobby for increased investment in renewable energy as part of contract agreements with LG&E • Offer tax abatement incentive programs for commercial new construction that achieves LEED certification • Require all new Louisville Metro-owned buildings to achieve LEED Silver certification or better	• No actions currently underway
State Solutions	• Adopt improvements to the Kentucky Building Code and requirements set for energy performance for new commercial and institutional buildings	• No actions currently underway

C-2. Existing Commercial & Institutional Building Retrofits

Description

Deep energy retrofits can achieve reductions in energy consumption of 50% or greater through whole-building analyses and retrofits of multiple building systems at the same time. Common strategies to achieve deep energy retrofits include making improvements to the building exterior (e.g., insulation, air sealing) coupled with upgrades to heating, cooling, lighting, and hot water systems. Architectural strategies can also be used to provide 'free' services from natural ventilation and the use of daylight rather than lighting fixtures to illuminate building interiors. 'Smart' building system technologies further increase efficiency by centrally managing building systems and controlling interior conditions based on demand. Geo-exchange (geothermal) systems are growing in popularity, including larger systems serving multiple buildings. The type of soil will impact the cost and effectiveness of the ground field. Other similar heat sources, such as groundwater or water from wastewater treatment can also be used with geo-exchange technology.

Louisville Metro can promote and incentivize building owners to investigate and implement energy conservation measures. Louisville Metro should start small and cap any incentive / grant program at a limited number of applicants to test the interest in the community without committing to a large grant program and to focus investment on incentive programs that will provide the best return on investment.

This strategy will require investment by commercial building owners and the timeline will vary depending on the level of support received from the local business community. Completing retrofits of existing commercial buildings could offer the potential for a cumulative avoidance of 703,200 tCO_2e by 2050, representing a 3.75% reduction in emissions over the BAU scenario.

C-2 Logistics

Timeline	Estimated Cost	Responsibility	Tracking Metrics
Medium-Long-Term	Moderate direct costs to Louisville Metro for completion of studies and to support rebate and incentive programs. Moderate direct costs to retrofit existing Louisville Metro-owned buildings.	Lead Agency: Develop Louisville Key Partners: LG&E, Louisville Energy Alliance, Kentucky Pollution Prevention Center, Greater Louisville, Inc., University of Louisville, State Historic Preservation Office	• Participation in incentive programs (number of buildings reached) • Annual investment level in incentives programs ($) • Energy and/or carbon reductions achieved per $ invested

Commercial & Institutional Buildings

C-2 Solutions

Financing/Policy Strategy	Implementation Actions	Status
Local Solutions - with funding needs	• Conduct recommissioning of existing Louisville Metro-owned buildings and facilities • Provide financial incentives and/or mechanisms to institutional and commercial property developers that voluntarily commit to efficiency upgrades • Study existing incentive programs used by comparable communities to inform the creation of programs for our community that will provide best value • Install building automation and controls such as adaptive thermostats, lighting sensors, and plug load monitors • Partner with local educational institutions to offer and promote educational programs focused on low or zero-emissions building design • Commission pilot studies in partnership with local business partners to demonstrate business case for deep energy retrofits	• Louisville Metro uses Energy Savings Performance Contracts to reduce energy use. • Louisville's Energy Project Assessment District (EPAD) program allows property owners to repay private loans for energy efficiency, renewable energy and water conservation measures.
Local Solutions - without funding needs	• Require the consideration of renewable and alternative energy considerations in the planning and design of new buildings and for retrofits of existing buildings to enable low-cost future installation - 'solar-ready' construction • Create a platform for voluntary commercial building energy benchmarking program	• No actions currently underway
State Solutions	• State Historic Preservation Office provide guidance for how federal and state historic rehab tax credits may be used for energy efficiency upgrades	• No actions currently underway

C-3. Solar PV on 25% of Commercial & Institutional Buildings

Description

Installation of solar panels on commercial and institutional buildings will increase the availability of renewable energy for local businesses, reducing their reliance on the electricity grid and offsetting emissions associated with grid-based electricity generation, transmission, and consumption.

Commercial rooftop and parking lot solar energy generation is a proven technology that has experienced significant price decreases in recent years for installation and maintenance. It is expected that solar energy will provide a compelling business case for business owners in future years, which will incentivize installation across Louisville. In 2017, Louisville Metro was awarded a gold designation by SolSmart, a program funded by the U.S. Department of Energy. This designation recognizes Louisville Metro's efforts to create a supportive environment for solar installation, such as the installation of 2,400 panels on the roof of Oxmoor Center in 2017, by reducing red tape and barriers to consumer adoption of solar energy.

Increased adoption and installation of rooftop solar power generation could offer the potential for a cumulative avoidance of 1,002,113 tCO_2e by 2050, representing a 5.34% reduction in emissions over the BAU scenario.

C-3 Logistics

Timeline	Estimated Cost	Responsibility	Tracking Metrics
Long-Term	Moderate direct upfront costs to Louisville Metro from installation of new solar capacity. Upfront costs offset by reduced energy costs over lifespan of solar panels.	Lead Agency: Develop Louisville Key Partners: Solar Over Louisville, Louisville Energy Alliance, LG&E, Building Industry Association of Louisville, Greater Louisville, Inc., Jefferson County Public Schools, University of Louisville, Partnership for a Green City, Jefferson Community & Technical College, Green Building Council	• Solar generation capacity for Louisville Metro-owned properties (MW) • Solar generation capacity for commercial properties (MW)

Commercial & Institutional Buildings

C-3 Solutions

Financing/Policy Strategy	Implementation Actions	Status
Local Solutions - with funding needs	• Commission studies to evaluate feasibility of micro-generation technology (e.g., solar photovoltaic, combined heat and power, etc.) in Louisville Metro's existing municipal buildings beyond the seven buildings which currently have solar energy generating capacity • Develop and publicize local financing options such as bulk purchasing, or leasing panels from local solar installers to help reduce upfront cost • Louisville Metro will explore participating in LG&E's Solar Share program and assist with promoting the program to area businesses.	• LG&E Solar Share Program
Local Solutions - without funding needs	• Expedite permitting processes for solar installations • Require the consideration of renewable and alternative energy in the planning and design of new buildings and for retrofits of existing buildings to enable low-cost future installation - 'solar-ready' construction • Advocate for a feed-in tariff or net metering program which would promote energy security while supporting the business case for adoption of renewable energy locally • Eliminate barriers by reducing building permit fees • Implement clear zoning regulations that allow solar energy installations on the rooftops and parking lots of commercial properties	• Louisville Metro simplified building permit for solar installations
State Solutions	• Adopt stronger state financial incentives for solar energy, ambitious renewable electricity standards, and comprehensive solar rights policies • Adopt an increasing-over-time Renewable Energy Portfolio Standard to drive increasing investments in renewable energy for all sectors	• No actions currently underway

C-4. Renewable Natural Gas in 20% of Commercial Buildings

Description

RNG is natural gas that is derived from organic waste material sources such as food waste, garden and lawn clippings, and animal and plant-based materials. RNG can also be derived from paper, cardboard, and wood. Common RNG sources include WWTP, dairies and agricultural sources, and landfills and solid waste. The local abundance of these materials provides potential for vast quantities of biogas to be produced.

RNG provides carbon emissions reductions in comparison to traditional natural gas as it avoids emissions associated with gas extraction, refining, transportation, and storage. RNG also enables the capture of greenhouse gas emissions such as methane from landfill gas for beneficial reuse as a heating source. Increased use of renewable natural gas in commercial buildings could offer the potential for a cumulative avoidance of 79,573 tCO_2e by 2050, representing a 0.42% reduction in emissions over the BAU scenario.

C-4 Logistics

Timeline	Estimated Cost	Responsibility	Tracking Metrics
Medium Term	Low direct cost to Louisville Metro, moderate to high cost to RNG providers	Lead Agency: Public Works Key Partners: Waste Management, Rumpke, Eco-Tech, MSD	• Volume of RNG produced or sold annually (GJ)

C-4 Solutions

Financing/Policy Strategy	Implementation Actions	Status
Local Solutions - with funding needs	• Support efforts to build infrastructure to capture and clean biogas from WWTP and landfills • Complete a market analysis of renewable natural gas opportunities accessible to Louisville Metro and rationale for investment • Provide incentives to use biogas for energy needs	• Waste Management of Kentucky began capturing natural gas at the Outer Loop Recycling and Disposal Facility in June 2018 • Rumpke has plans to begin construction of a methane capture system at their Medora landfill in 2020
Local Solutions - without funding needs	• Use existing pipelines to deliver this renewable energy to buildings • Allow excess heat and electricity generated by the RNG production process to be sold back to electric companies • Introduce a new policy to provide a framework for the purchase and delivery of RNG to commercial customers for space and water heating	• Natural gas captured at the Outer Loop Recycling and Disposal Facility is sold at a vehicle fueling station and to LG&E for their natural gas delivery system
State Solutions	• Pass legislation that funds a study to identify the technical potential of RNG in Kentucky	• No actions currently underway

C-5. Building Energy Benchmarking Program

Description

An effective way to reduce energy use in commercial buildings is to foster awareness and positive competition by creating a common understanding of energy use patterns in Louisville. By creating a platform where local businesses and industries can track, report, and compare their consumption, opportunities are created for organizations to learn from one another and become more energy efficient. Benchmarking and disclosure of energy use can help reduce the informational gaps that limit investment in energy efficiency improvements and create opportunity for collaboration. Disclosure of information on energy use increases the visibility of high-energy-consuming buildings. This helps buyers incorporate energy consumption patterns into their process of choosing an investment and incentivizes property owners and managers to make investments to remain competitive.

Creation of a building energy benchmarking program for commercial and institutional buildings could offer the potential for a cumulative avoidance of 254,079 tCO_2e by 2050, representing a 1.35% reduction in emissions over the BAU scenario.

C-5 Logistics

Timeline	Estimated Cost	Responsibility	Tracking Metrics
Short-Term	Limited costs to Louisville Metro to establish and oversee a suitable digital platform and to promote and raise awareness of the program	Lead Agency: Develop Louisville Key Partners: LG&E, Greater Louisville, Inc., LEA	• Participation in the energy benchmarking program (square footage of buildings participating)

C-5 Solutions

Financing/Policy Strategy	Implementation Actions	Status
Local Solutions - with funding needs	• Implement a public recognition program in phases to build momentum and showcase local leaders • Create or utilize an existing platform (e.g., Energy Star Portfolio Manager) to host a voluntary commercial building energy benchmarking program • Conduct building inventories and set realistic goals for businesses interested in participating in this program	• Louisville Energy Alliance sponsors the Kilowatt Crackdown, a voluntary benchmarking program
Local Solutions - without funding needs	• Utilize any free internal and external resources for promotion, such as websites, e-newsletters, or utility bill inserts • Create a working group or organization dedicated to building momentum within the local business community to participate in a voluntary benchmarking program • Adopt an ordinance that requires large buildings to annually benchmark and report their energy consumption	• Louisville Energy Alliance offers a variety of programs, including the Kilowatt Crackdown, to help buildings track and reduce their energy use
State Solutions	• No actions proposed	• No actions currently underway

Manufacturing Industries & Construction

Industrial sources, such as manufacturing, food processing, mining, and construction, produce about 29% of U.S. GHG emissions. These emissions result from a variety of processes, including the combustion of fossil fuels to generate heat and power and for chemical processes used in heavy manufacturing industries, including the production of iron, steel, and cement. In 2016, manufacturing industries and construction emissions accounted for approximately 20.8% of total emissions generated in Louisville (**Figure 5**).

Potential Contribution to Overall Reduction Target

Manufacturing industries can require significant quantities of energy, far more than an average home or office building. As energy-intensive industries, even small changes in consumption can have a large effect on overall emissions generated.

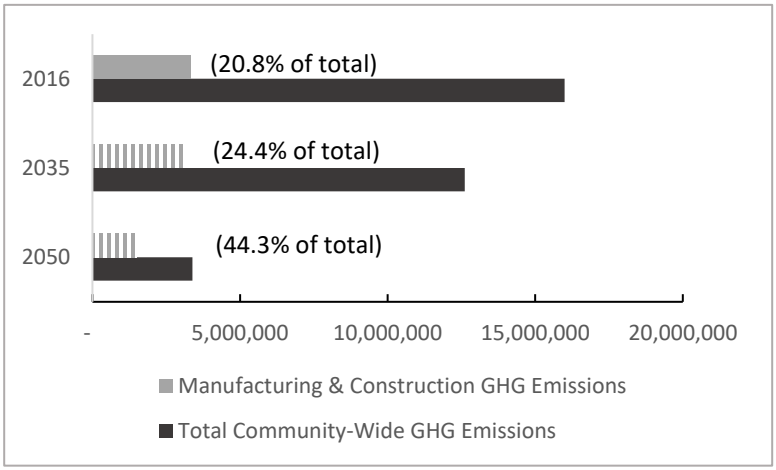


Figure 5. GHG Contributions by Manufacturing and Construction Sector

The size of these industries also creates unique opportunities. Some industries may operate their own energy generation sources on-site, while others benefit from co-locating with businesses that find value in byproducts that they produce. For example, industries that generate a lot of heat could partner with nearby buildings to sell or share this heat for beneficial use to heat office spaces.

Co-Benefits

Energy conservation strategies can offer significant financial savings to industries, especially those that require large quantities of energy to manufacture their products. Conversion of power generating capacity to cleaner sources will contribute to improved air quality, which can have a positive effect on the health and wellbeing of employees. Finding opportunities to co-locate or connect building systems through combined heat and power or other forms of district energy systems will also reduce energy costs.

M-1. Existing Manufacturing Facility Retrofits

Description

Many existing buildings were built decades ago using technologies and construction practices that were common to those eras. Modern improvements to construction practices, material properties, and building operation and management offer significant opportunity to reduce on-site energy use.

Deep energy retrofits can achieve reductions in energy consumption of 50% or greater through whole-building analyses and retrofits of multiple building systems at the same time. Common strategies to achieve deep energy retrofits include making improvements to the building exterior (e.g., insulation, air sealing) coupled with upgrades to heating, cooling, lighting, and hot water systems. Architectural strategies can also be used to provide 'free' services from natural ventilation and the use of daylight rather than lighting fixtures to illuminate building interiors. 'Smart' building system technologies further increase efficiency by centrally managing building systems and controlling interior conditions based on demand.

Completing deep energy retrofits of existing manufacturing and industrial facilities could offer the potential for a cumulative avoidance of 447,930 tCO_2e by 2050, representing a 2.39% reduction in emissions over the BAU scenario.

M-1 Logistics

Timeline	Estimated Cost	Responsibility	Tracking Metrics
Medium-Long-Term	High capital costs to manufacturers to complete retrofits, offset by reduced operating and energy costs.	Lead Agency: Develop Louisville Key Partners: LG&E, Greater Louisville, Inc., Kentucky Association of Manufacturers, Louisville Energy Alliance, Kentucky Pollution Prevention Center	• Annual energy consumption (kWh, GJ) • Participation in incentive programs (number of buildings reached) • Annual investment level in incentives programs ($) • Energy and/or carbon reductions achieved per $ invested

M-1 Solutions

Financing/Policy Strategy	Implementation Actions	Status
Local Solutions – with funding needs	• Commission pilot studies in partnership with local business partners to demonstrate business case for deep energy retrofits	• No actions currently underway
Local Solutions - without funding needs	• Advocate for the reinstatement of LG&E's Commercial Rebate program to provide a consistent process and funding source to support building retrofit programs	• No actions currently underway
State Solutions	• Approve a Short-Lived Climate Pollutant Reduction Strategy which sets statewide targets of reducing methane and hydrofluorocarbons (HFCs)	• No actions currently underway

M-2. Combined Heat and Power Facility

Description

Cogeneration, or combined heat and power, is the use of a thermal power station to generate electricity and useful heat at the same time. Heat is typically a by-product from energy production from fossil fuel combustion that is 'wasted' and vented to the atmosphere. The typical fossil fuel-powered electricity power plant has an efficiency of up to 45%, while Combined Heat and Power (CHP) plants have an efficiency as high as 80%, which is achieved by avoiding the waste of thermal energy[17].

Under this strategy, if LG&E constructs a new natural gas-fired facility, it should generate both electricity and heat that is captured for beneficial reuse. This reuse could be accomplished by locating the facility in proximity to existing industrial or large commercial office buildings that require space heating to maintain indoor ambient air temperatures. The facility would be linked to these buildings through a district energy system.

Building a combined heat and power facility in Louisville could offer the potential for a cumulative avoidance of 23,000 tCO_2e by 2050, representing a 0.12% reduction in emissions over the BAU scenario.

M-2 Logistics

Timeline	Estimated Cost	Responsibility	Tracking Metrics
Medium-Term	High capital costs to construct new facility offset by lower space heating costs.	Lead Agency: LG&E Key Partners: Develop Louisville, Building Industry Association of Louisville, Greater Louisville, Inc., Kentucky Association of Manufacturers	• Generating capacity of CHP plant (kWh)

M-2 Solutions

Financing/Policy Strategy	Implementation Actions	Status
Local Solutions - with funding needs	• Complete a study to determine feasibility and ideal locations for CHP facilities • Support the adoption and deployment of CHP and district energy systems through zoning and planning activities	• No actions currently underway
Local Solutions - without funding needs	• Revisit land use planning restrictions and policies to confirm that local policies support and enable development of CHP and district energy systems	• No actions currently underway
State Solutions	• No actions proposed	• No actions currently underway

[17] United States Environmental Protection Agency (2019). Combined Heat and Power (CHP) Partnership. https://www.epa.gov/chp/what-chp

M-3. Building Energy Benchmarking Program

Description

An effective way to reduce energy use in industrial buildings is to foster awareness and positive competition by creating a common understanding of energy use patterns in Louisville. By creating a platform where local businesses and industries can track, report, and compare their consumption, opportunities are created for organizations to learn from one another and become more energy efficient. Benchmarking and disclosure of energy use can help reduce the informational gaps that limit investment in energy efficiency improvements and create opportunity for collaboration. Disclosure of information on energy use increases the visibility of high-energy-consuming buildings. This program would be implemented in concert with the commercial buildings' benchmarking program.

Creation of a building energy benchmarking program for industrial buildings could offer the potential for a cumulative avoidance of 115,119 tCO_2e by 2050, representing a 0.61% reduction in emissions over the BAU scenario.

M-3 Logistics

Timeline	Estimated Cost	Responsibility	Tracking Metrics
Short-Term	Limited costs to Louisville Metro to establish and oversee a suitable digital platform and to promote and raise awareness of the program	Lead Agency: Develop Louisville Key Partners: LG&E, Greater Louisville, Inc., Kentucky Association of Manufacturers, Louisville Energy Alliance, Kentucky Pollution Prevention Center	• Participation in the energy benchmarking program (square footage of buildings participating)

M-3 Solutions

Financing/Policy Strategy	Implementation Actions	Status
Local Solutions - with funding needs	• Create or utilize an existing platform (e.g., Energy Star Portfolio Manager) for a voluntary building energy benchmarking program for major local employers and energy consumers • Conduct building inventories and set realistic goals for businesses interested in being involved • Implement recognition program in phases to build momentum	• No actions currently underway
Local Solutions - without funding needs	• Utilize any free internal and external resources for promotion, such as websites, e-newsletters, or utility bill inserts • Create a working group or organization dedicated toward building momentum within the local manufacturing community to participate in this voluntary program	• No actions currently underway
State Solutions	• No actions proposed	• No actions currently underway

M-4. Renewable Natural Gas in 50% of Manufacturing Facilities

Description

RNG is natural gas that is derived from organic waste material sources such as food waste, garden and lawn clippings, and animal and plant-based materials. RNG can also be derived from paper, cardboard, and wood. Common RNG sources include WWTP, dairies and agricultural sources, and landfills and solid waste. The local abundance of these materials, particularly distilling waste, provides potential for production of vast quantities of biogas.

RNG provides carbon emissions reductions in comparison to traditional natural gas as it avoids emissions associated with gas extraction, refining, transportation, and storage. RNG also enables the capture of GHG emissions such as methane from landfill gas for beneficial reuse as a heating source. Increased use of renewable natural gas in industrial buildings could offer the potential for a cumulative avoidance of 237,569 tCO_2e by 2050, representing a 1.27% reduction in emissions over the BAU scenario.

M-4 Logistics

Timeline	Estimated Cost	Responsibility	Tracking Metrics
Medium-Term	Low direct cost to Louisville Metro, moderate to high cost to RNG providers	Lead Agency: Public Works Key Partners: Waste Management, Rumpke, Eco-Tech, MSD, Kentucky Association of Manufacturers	• Volume of RNG produced or sold annually (GJ)

M-4 Solutions

Financing/Policy Strategy	Implementation Actions	Status
Local Solutions - with funding needs	• Authorize infrastructure to capture and clean biogas from WWTP and landfills • Complete a market analysis of renewable natural gas opportunities accessible to Louisville Metro and rationale for investment • Provide incentives to use biogas for energy needs	• Waste Management of Kentucky began capturing natural gas at the Outer Loop Recycling and Disposal Facility in June 2018 • Rumpke has plans to begin construction of a methane capture system at their Medora landfill in 2020
Local Solutions - without funding needs	• Use existing pipelines to deliver this renewable energy to manufacturing facilities • Allow excess heat and electricity generated by the RNG production process to be sold back to electric companies • Support policy to provide a framework for the purchase and delivery of RNG to industrial customers for space and water heating	• Natural gas captured at the Outer Loop Recycling and Disposal Facility is sold at a vehicle fueling station and to LG&E for their natural gas delivery system
State Solutions	• Propose a study to identify the technical potential of RNG in Kentucky	• No actions currently underway

M-5. Fuel Switch from Combustion of Coal to Natural Gas

Description

This strategy accounts for the conversion of any existing facilities that utilize coal as a source to generate on-site heating to natural gas or renewable fuel, if possible. Although very few buildings in Louisville utilize coal to generate heat on-site, natural gas generates significantly less GHG emissions, making this an impactful strategy.

Conversion of buildings that currently use coal to natural gas could offer the potential for a cumulative avoidance of 34,162 tCO_2e by 2050, representing a 0.18% reduction in emissions over the BAU scenario.

M-5 Logistics

Timeline	Estimated Cost	Responsibility	Tracking Metrics
Short-Term	No direct cost to Louisville Metro. High capital cost to install new generating capacity for organizations currently utilizing coal that could be offset by the need to replace aging equipment	Lead Agency: Develop Louisville Key Partners: Air Pollution Control District, University of Louisville, Kentucky Association of Manufacturers	• Number of facilities utilizing coal to generate space heating

M-5 Solutions

Financing/Policy Strategy	Implementation Actions	Status
Local Solutions - with funding needs	• Provide incentives or other forms of financial assistance to facilitate conversion from coal to natural gas for on-site heating, potentially in partnership with local gas providers	• No actions currently underway
Local Solutions - without funding needs	• Restrict the use of coal to provide heat and hot water within Louisville Metro boundaries	• No actions currently underway
State Solutions	• No actions proposed	• No actions currently underway

Energy Industry

Currently, electricity that is provided to Louisville by LG&E is primarily generated from fossil fuel sources. This strategy considers the opportunity for emissions reduction from conversion of power generation sources to low-carbon options (e.g., natural gas, renewable energy). This strategy assumes that LG&E will reduce the carbon intensity factor of the electricity grid by 70% by 2050 from 2016 levels[18].

Potential Contribution to Overall Reduction Target

Shifting the mix of energy sources used to generate electricity in Louisville Metro will have the single largest impact on emissions. Electricity generation and consumption within Louisville represents the greatest source of emissions, accounting for 9,883,480 tonnes of CO_2e in 2016, or approximately 62% of total emissions.

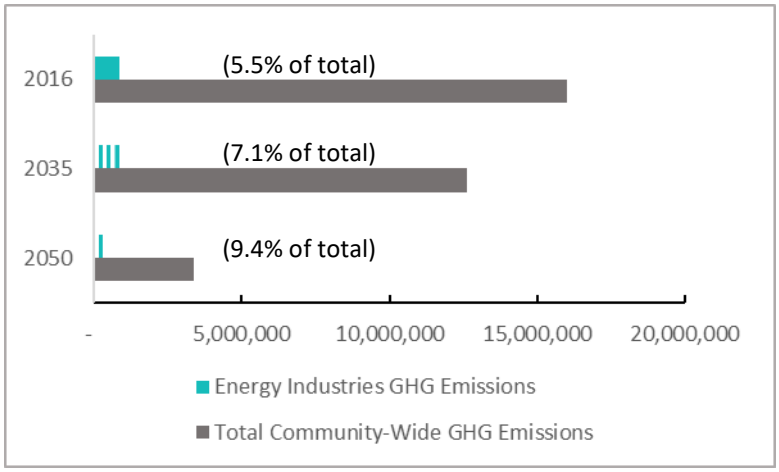


Figure 6. GHG Contributions by Energy Industry Sector

The benefits of transitioning to fuel sources with lower carbon intensity (e.g., natural gas, renewable energy) will be felt across all sectors that use electricity. Because of how electricity-based emissions are assigned, only a small portion of reductions resulting from changes in the carbon intensity of electricity production are reflected in the Energy Industry emissions. Most of these reductions are allocated across Stationary Energy Sub-Sectors (i.e., residential, commercial, and manufacturing buildings).

Co-Benefits

By reducing reliance on fossil fuel energy sources, we can anticipate improved air quality in Louisville. Traditional energy generation from fossil fuel sources also requires a large volume of water. Transition to renewable energy sources will limit water withdrawals protecting local water bodies. Investment in new forms of energy generation may also create new industries and job opportunities locally to build, operate, and maintain renewable energy installations.

[18] LG&E's parent company, PPL, has a stated goal of reducing the company's carbon dioxide emissions by 70% by 2050. https://www.pplweb.com/sustainability/climate-action/

E-1. 70% Energy Generation Intensity Factor Reduction

Description

Currently, electricity that is provided to Louisville by LG&E is primarily generated from fossil fuel sources[19]. This strategy considers the opportunity for emissions reduction from conversion of power generation sources to renewable energy or lower carbon options.

As power generation and distribution is outside of the direct influence of Louisville Metro, actions are limited to policy and supportive actions that would assist LG&E in transitioning toward more renewable and low-carbon sources of energy.

Changing our source of energy for electricity will have the single largest impact on our community GHG emissions. The transition to a future electricity grid with a 70% lower carbon intensity factor will potentially offer a cumulative avoidance of 7,553,055 tCO_2e by 2050, representing a 40.2% reduction in emissions over the BAU scenario.

Note that this includes emissions reductions associated with end-use and is not reflective solely of LG&E operations (i.e. LG&E is the service provider; the use of low-carbon fuel sources to meet electricity demand in our homes and businesses represents the single largest opportunity for emissions reduction). **Table 5** shows the breakdown by Sector for reductions associated with reducing the carbon intensity factor of electricity production.

Table 5. Sector Reductions from Energy Generation Intensity Factor Reduction

Sector	tCO_2e Reduction
Residential Buildings	2,571,665
Commercial & Institutional Buildings	2,832,398
Manufacturing Industries & Construction	1,524,870
Energy Industry	624,122
Total	7,553,055

[19] The recently upgraded Ohio Falls Hydroelectric Plant can only produce the equivalent of up to 7% of Louisville's 2016 electricity use and 6% of Louisville's 2050 BAU forecasted electricity use at its current 100-megawatt capacity. https://lge-ku.com/our-company/community/neighbor-neighbor/ohio-falls-generating-station

Energy Industry

E-1 Logistics

Timeline	Estimated Cost	Responsibility	Tracking Metrics
Long-Term	No direct cost to Louisville Metro. Costs to install new generating capacity and retire legacy generating facilities are likely to affect rates paid by consumers for electricity.	Lead Agency: LG&E Key Partners: Mayor's Office, Develop Louisville, Air Pollution Control District	• Energy mix of local electricity grid (%) • Local generating capacity from renewable energy (MW)

E-1 Solutions

Financing/Policy Strategy	Implementation Actions	Status
Local Solutions - with funding needs	• Continue to provide policy, information and financing support to Louisville residents seeking to install solar generation capacity. Consider opportunities to increase support where possible • Directly support feed-in tariff programs where long-term contracts are signed supporting renewable energy providers through provision of greater price certainty	• Louisville Metro has multiple programs for streamlining permits and assisting property owners with financing.
Local Solutions - without funding needs	• Leverage negotiating power (through Louisville Metro's size as a customer) to lobby for increased investment in renewable energy as part of Louisville Metro's contract agreements with LG&E • Lobby state legislators and advocate for legislation to allow feed-in-tariff programs and create a positive environment for investment in renewable energy	• No actions currently underway
State Solutions	• Pass legislation to allow feed-in-tariff programs and create a positive environment for investment in renewable energy	• No actions currently underway

E-2. Demand Side Management (DSM) Program

Description

Demand-side management (DSM) refers to strategies undertaken to reduce end-consumer demand for energy. DSM strategies typically consist of incentives, education programs, building energy labelling programs, peak or load shifting, and the introduction of distributed energy generation and storage capacity. This strategy would introduce actions to shift energy loads to reduce peak demands for electricity. This could be accomplished through the introduction of time-of-use rates or incentives (e.g., consumers pay more for electricity during times of peak demand), remote control of energy-intensive appliances and equipment to cycle use during peak hours, and / or voluntary demand response incentives programs for major energy consumers and industrial sites.

Introduction of utility-scale demand side management would offer the potential for a cumulative avoidance of 56,549 tCO_2e by 2050, representing a 0.30% reduction in emissions over the BAU scenario.

E-2 Logistics

Timeline	Estimated Cost	Responsibility	Tracking Metrics
Short-Medium-Term	Limited costs to Louisville Metro to establish benchmarking programs and other pilot programs. Moderate costs to LG&E to enable peak / load-shifting capability.	Lead Agency: LG&E Key Partners: Greater Louisville, Inc., Kentucky Association of Manufacturers	• Level of participation in DSM programs by local businesses and manufacturers • Capacity for peak / load-shifting

E-2 Solutions

Financing/Policy Strategy	Implementation Actions	Status
Local Solutions - with funding needs	• Develop and implement a pilot residential energy labeling program (at time of sale) for residential homes – ENERGY STAR certified homes program • Create a platform for voluntary commercial building energy benchmarking program for major local employers and energy consumers	• No actions currently underway
Local Solutions - without funding needs	• Advocate for LG&E to implement a peak / load-shifting program to reduce peak consumption	• LG&E's residential Time of Day rate programs offer savings based on the time of day of electricity is used.
State Solutions	• No actions proposed	• No actions currently underway

E-3. LEDs in Lighting Fixtures and Streetlights

Description

This strategy involves the replacement of existing Louisville streetlights, traffic lights, and other public lighting fixtures with high-efficiency LED bulbs. LED bulbs typically have longer lifespans than traditional incandescent bulbs or fluorescent bulbs while using less electricity. Re-lamping programs would reduce annual operational energy demands, reduce operational costs, and reduce emissions.

Upgrades to public lighting fixtures could offer the potential for a cumulative avoidance of 16,846 tCO_2e by 2050, representing a 0.09% reduction in emissions over the BAU scenario.

Louisville Metro has already taken significant steps to upgrade lighting. Effectively all of the traffic signals in Jefferson County were converted to LED fixtures in 2007 and 2008. Streetlights in the Central Business District are upgraded to LED fixtures on an ongoing basis as replacement is required. Louisville Metro and LG&E are in the planning stages of a program for the Urban Services District to replace streetlights mounted on utility poles with LED fixtures.

E-3 Logistics

Timeline	Estimated Cost	Responsibility	Tracking Metrics
Short-Term	Limited cost to Louisville Metro to conduct streetlight re-lamping program.	Lead Agency: Public Works, Facilities, Parks and Recreation Key Partners: LG&E	• Percentage of streetlights converted to high-efficiency bulbs (%)

E-3 Solutions

Financing/Policy Strategy	Implementation Actions	Status
Local Solutions - with funding needs	• Evaluate opportunities to implement a conversion program for Louisville streetlights and provide a recommendation to Council for appropriate financing models to support this investment • Complete pilot projects to evaluate costs and benefits of adaptive lighting technology and to determine feasibility of broader implementation.	• Streetlights in the Central Business District are upgraded to LED fixtures on an ongoing basis as replacement is required. Louisville Metro and LG&E are in the planning stages of a program for the Urban Services District to replace streetlights mounted on utility poles with LED fixtures
Local Solutions - without funding needs	• Support small cities and neighborhood associations in converting fixtures to LEDs • Collaborate with LG&E to establish a transition plan for existing LG&E owned fixtures.	• No actions currently underway
State Solutions	• No actions proposed	• No actions currently underway

Transportation

Transportation sector emissions are those that arise from the combustion of fuels in journeys conducted by personal and commercial vehicles (including public transit vehicles) on Louisville roadways, railways, for ships and airplanes, and for off-road vehicles. The combustion of fossil fuels, like gasoline in the engines of motor vehicles, directly generates GHG emissions, while the use of grid-supplied electricity for hybrid or electric vehicles indirectly generates GHG emissions. In 2016, transportation emissions accounted for approximately 18.7% of total emissions generated in Louisville (**Figure 7**). On-road vehicles are the primary source for transportation emissions (91%+), while railways, waterborne, and aviation sources are comparatively minor contributors to transportation emissions in Louisville.

Transportation emissions are strongly linked to land use policy and planning decisions. The structure of the urban environment affects driving habits and the distance that must be traveled to workplaces, recreational facilities, schools, and other landmarks. Transportation emissions are also affected by the availability of viable and attractive public transit and alternative transportation modes (e.g., cycling, dockless vehicles, and walking). Supportive policies and infrastructure for carpooling and electric car use will affect how residents of Louisville choose to travel and will affect the types of fuel used to complete trips.

Potential Contribution to Overall Reduction Target

Reductions experienced to date in transportation emissions were largely achieved due to increased fuel efficiency standards for personal vehicles established through federal regulations. Over time, it is expected that automobile technology and design will continue to improve, offering greater fuel efficiency and reducing emissions. By 2050, it is anticipated that a reduction of more than 5% of overall Louisville emissions may be achieved solely through increased fuel efficiency of vehicles. Beyond anticipated improvements to vehicle fuel efficiency, active measures that Louisville Metro could take to reduce transportation emissions would achieve approximately 20% of the reduction required to reach the 80% by 2050 commitment.

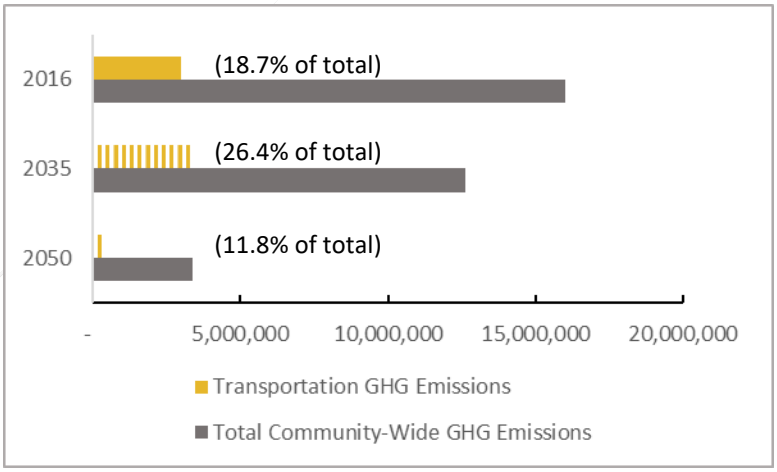


Figure 7. GHG Contributions by Transportation Sector

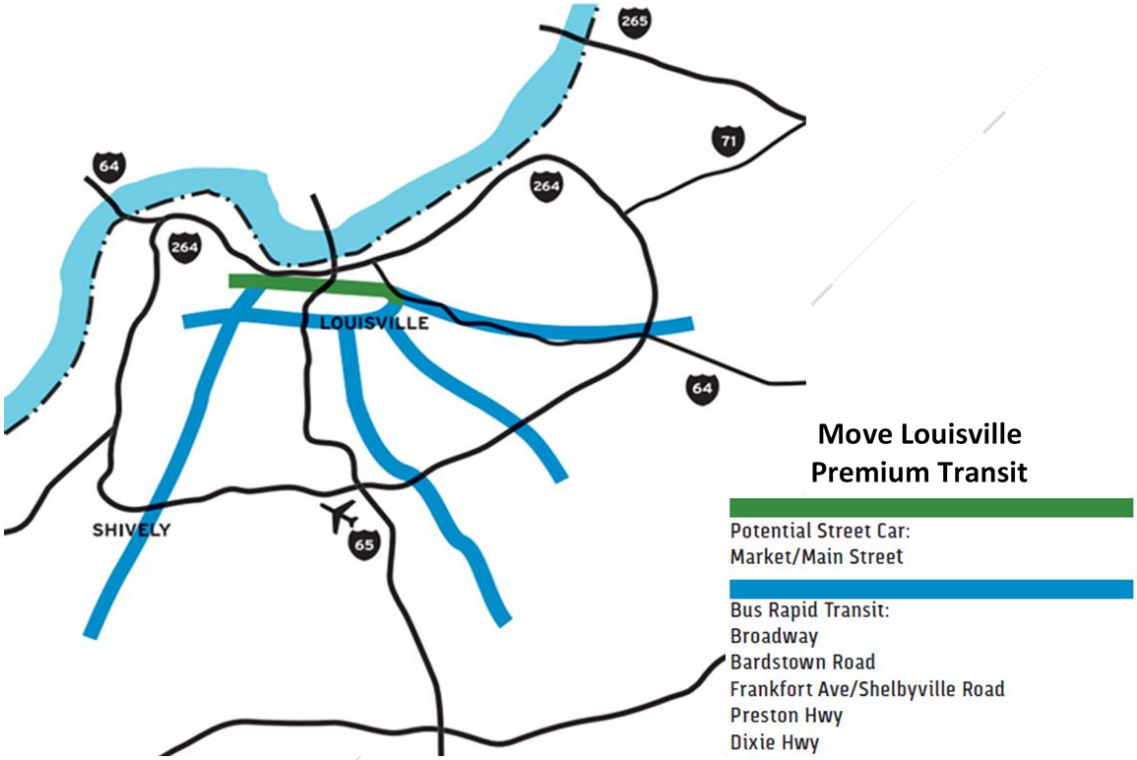
Co-Benefits

Combustion of diesel and gasoline in vehicle motors releases air pollutants including particulate matter (PM), volatile organic compounds (VOCs), nitrogen oxides (NOx), carbon monoxide (CO), and sulfur dioxide (SO_2). These compounds increase the formation of ground-level ozone and can pose health risks to babies and young children and to people suffering from chronic illness. Individuals with asthma or other respiratory or heart conditions are also at increased risk. A transition to a greater use of public transit, electric vehicles, and other alternative modes of transportation (e.g., walking, cycling) can help improve air quality in Louisville by reducing tailpipe emissions.

T-1. Increased Densification

Description

Plan 2040 and Move Louisville[20] both include goals related to directing development toward key urban nodes (e.g., along major transportation and transit corridors and development in proximity to major sources of employment) resulting in increased density that encourages residents to walk, cycle, and take transit more frequently than they do at present. This will contribute to reduced reliance on personal vehicle use and will therefore reduce annual vehicle miles traveled. Increased densification could offer the potential for a cumulative avoidance of 499,519 tCO_2e by 2050, representing a 2.66% reduction in emissions over the BAU scenario.



T-1 Logistics

Timeline	Estimated Cost	Responsibility	Tracking Metrics
Medium-Term	No direct cost to Louisville Metro. Anticipated indirect costs to developers. This strategy could result in net income to Louisville Metro through higher property tax revenues and decreased roadway expansion expenditures.	Lead Agency: Develop Louisville Key Partners: TARC, Building Industry Association of Louisville, Urban Land Institute	• Vehicle miles traveled • Neighborhood walkability scores • Real estate investment / # of high-density developments per year • Modes of transportation to work

[20] Move Louisville is the city's 20-year multi-modal plan. https://louisvilleky.gov/government/advanced-planning/move-louisville

Transportation

T-1 Solutions

Financing/Policy Strategy	Implementation Actions	Status
Local Solutions - with funding needs	• Prioritize and incentivize further development along premium transit corridors as well as in traditional, town center, and urban center form districts that are walkable and which are accessible to trails and connections to services and transit, in alignment with the policies and goals of Plan 2040 and Move Louisville • Offer density bonuses to developers which allow denser development than normally permitted in exchange for providing a public good: green space, public housing, etc. • Incentivize developers to conduct land assembly to consolidate smaller pieces of land into larger plots to build larger buildings and promote community revitalization • Adopt land development and property tax policies that incentivize more intense development on surface parking lots downtown and in urban neighborhoods	• Move Louisville and Plan 2040 include several goals supporting higher density, more sustainable development
Local Solutions - without funding needs	• Update parking requirements in Land Development Code to reduce or eliminate parking requirements • Rezone land along premium transit corridors as outlined in Move Louisville to promote a denser urban form • Create conservation districts and other land development policies to discourage development in areas remote from the City's core and other urban centers of importance • Implement policies to allow the conversion of land that is currently zoned for single-family residential and light commercial uses to higher density mixed-use development	• Land Development Code parking requirements were updated in 2018 and eliminated parking minimums downtown. • Move Louisville and Plan 2040 include several goals supporting higher density, more sustainable development
State Solutions	• No actions proposed	• No actions currently underway

T-2. Active Transportation and Ridesharing

Description

Creating options for residents to complete trips without relying on the use of personal vehicles by using active transportation modes (e.g., bicycling and walking) and ride-sharing can empower them to choose more sustainable and healthier options, will reduce reliance on personal vehicle use, and will therefore reduce annual vehicle miles traveled in Louisville.

Increased adoption of active transportation options could offer the potential for a cumulative avoidance of 783,336 tCO_2e by 2050, representing a 4.17% reduction in emissions over the BAU scenario.

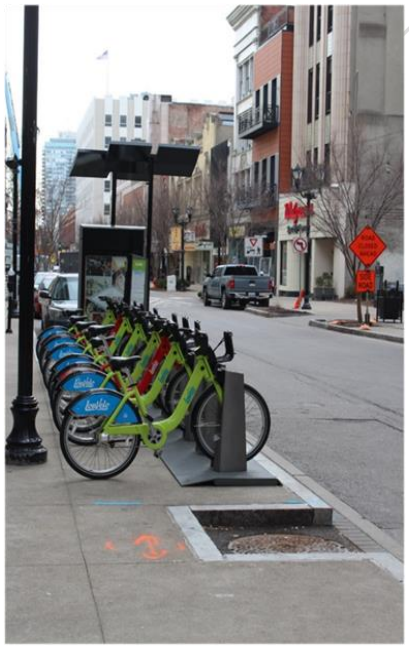
T-2 Logistics

Timeline	Estimated Cost	Responsibility	Tracking Metrics
Short-Medium-Term	No direct cost to Louisville Metro for many actions. Anticipated indirect costs to developers. Medium costs associated with bicycle and pedestrian facilities. Low cost for planning/studies.	Lead Agency: Public Works Key Partners: Kentuckiana Regional Planning & Development Agency, Parks & Recreation, Public Health & Wellness, Planning & Design, Building Industry Association of Louisville, KY Transportation Cabinet, Bicycling for Louisville	• Vehicle miles traveled • Neighborhood walkability scores • Modes of transportation surveys to include new and emerging modes • Number of bike racks and dedicated pathways available

Transportation

T-2 Solutions

Financing/Policy Strategy	Implementation Actions	Status
Local Solutions - with funding needs	• Introduce a bike-share program within the downtown city core and other high-density or high-potential cycling areas • Continue investing in ongoing improvements to existing sidewalk, pedestrian, transit, roadway, and bikeway infrastructure projects • Build more secure and protected bike parking and maintenance facilities across Louisville • Commission a study to identify high-potential areas for the construction of new, dedicated pedestrian and cyclist pathways	• Louvelo Bikeshare was launched in 2017 and the network currently consists of 32 stations and 321 bikes across the Downtown, Nulu, and Old Louisville. In 2018, the program reported almost 16,000 total trips. Louisville Metro commits funds annually for pedestrian and bicycle infrastructure.
Local Solutions - without funding needs	• Support opportunities for ridesharing and short-term vehicle use • Adopt updated Complete Streets policy to include current best practices • Require developers of new properties to offer bicycle parking options • Eliminate free parking policy for Louisville Metro employees • Tax downtown surface parking lots based on potential use value as opposed to PVA assessed value • Raise awareness of public transit and dockless vehicle programs for low-income residents	• KIPDA's Every Commute Counts program connects commuters with a variety of rideshare and active transportation options. • Louisville Metro supports the use of dockless vehicles and passed a new ordinance governing their use in July 2019. • Louisville Metro Council passed an updated Complete Streets ordinance in August 2019. • Louisville Metro's Land Development Code sets minimum bike parking requirements in certain circumstances.
State Solutions	• Introduce high-occupancy vehicle (HOV) lanes	• No actions currently underway



T-3. Improved Transportation Systems

Description

Increased investment in local transportation networks to improve efficiency, expand access to public transit, and improve public transit service quality for Louisville residents could contribute to a reduction of up to 27% in annual miles traveled per resident by personal vehicle by 2050. Investments may include existing high-ridership transit routes having more frequent service via the introduction of Bus Rapid Transit systems and adding new routes to expand the transit network.

Improved transportation networks could offer the potential for a cumulative avoidance of 254,079 tCO_2e by 2050, representing a 6.13% reduction in emissions over the BAU scenario.

T-3 Logistics

Timeline	Estimated Cost	Responsibility	Tracking Metrics
Short-Medium-Term	High cost associated with transit investments. Low cost for ridership subsidies.	Lead Agency: TARC Key Partners: Kentuckiana Regional Planning & Development Agency, KY Transportation Cabinet, Parking Authority of River City	• Annual transit ridership • Transit revenues • Geographic extent of transit network (e.g., miles of route service) • Service quality (rider surveys) • Reduction in vehicle miles traveled

T-3 Solutions

Financing/Policy Strategy	Implementation Actions	Status
Local Solutions - with funding needs	• Improve the transit fleet and route system to provide more frequent, efficient, and reliable transit service • Prioritize Bus Rapid Transit routes to high-frequency transit corridors • Continue to offer transit fare subsidies to eligible passengers: e.g., students, senior citizens, and citizens with disabilities • Implement enhancements to customer and user experience through improvements to public-facing websites, passenger tools, signage, and payment / purchasing systems • Improve transit stop infrastructure and amenities (e.g., signage, shelters, benches) to enhance safety and accessibility • Investigate strategic parking supply restrictions, toll roads, and congestion pricing for single-occupancy vehicles • Offer transit subsidies and reduced fares to major employers • Study the feasibility of free public transit	• In 2018, TARC began developing a Comprehensive Operations Analysis and began implementing a new route system in 2019. Additionally, TARC opened a new BRT system on Dixie Highway and 18th Street in January 2020.
Local Solutions - without funding needs	• Coordinate premium transit corridors with land use policies that promote density • Expand Louisville Metro's telecommuting policy and encourage other businesses to accommodate telecommuting for their employees	• Move Louisville and Plan 2040 include several goals supporting development along premium transit corridors.
State Solutions	• Update KY Transportation Cabinet's Strategic Highway Investment Formula for Tomorrow (SHIFT) scoring process to provide higher / more appropriate scoring for transit and non-motorized infrastructure investments	• No actions currently underway

T-4. Fuel Switching

Description

Existing vehicles in Louisville that use gasoline and diesel internal combustion engines will be gradually converted to or be replaced by low-carbon and alternative fuel vehicles (e.g., electric, hydrogen fuel cell, etc.). Current market projections indicate over 60% of new light-duty vehicle sales in the U.S. will be electric by 2050[21]. This strategy assumes that by 2050 at least 50% of all personal vehicle trips made in Louisville will occur in electric vehicles.

Switching to low-carbon or alternative fuel vehicles for 50% of all personal vehicle trips could offer the potential for a cumulative avoidance of 254,079 tCO_2e by 2050, representing a 3.75% reduction in emissions over the BAU scenario.

T-4 Logistics

Timeline	Estimated Cost	Responsibility	Tracking Metrics
Medium-Term	Low cost for planning/studies. Medium cost for electric vehicle infrastructure. Low cost for new vehicle replacement policies.	Lead Agency: Louisville Forward Key Partners: LG&E, Public Works Planning & Design, Parking Authority of River City, Codes and Regulations, Air Pollution Control District, Evolve KY, Louisville Metro Facilities & Fleet	• Number of electric vehicle chargers within Louisville Metro boundary • Proportion of electric and/or alternative fuel vehicles in Louisville Metro fleet

[21] Forbes (2019). 4 U.S. Electric Vehicle Trends To Watch In 2019.. https://www.forbes.com/sites/energyinnovation/2019/01/02/4-u-s-electric-vehicle-trends-to-watch-in-2019/#686aa35c5a3c

T-4 Solutions

Financing/Policy Strategy	Implementation Actions	Status
Local Solutions - with funding needs	• Implement a pilot project for electric-only transit buses • Complete an electric vehicle market adoption study to better understand the anticipated local demand for electric vehicles, the needs of users, barriers to adoption, and the cost of implementation to Louisville Metro • Expand the electric vehicle charging network by partnering with developers, building owners and managers to add new charging stations. Provide guidance and assistance to Louisville businesses and non-profits with obtaining funding and approvals to install and operate charging stations. • Develop and implement a local electric vehicle incentive and education programs for consumers and dealerships.	• LouLift is a complimentary downtown circulator service with nine fast-charging, all-electric buses that produce zero emissions • Drive Clean Louisville is a cross-functional team planning for and exploring opportunities related to electric vehicles and clean fuel transportation for our government and community
Local Solutions - without funding needs	• Establish a policy to replace Louisville Metro's highest mileage, on-road light and heavy-duty vehicles with the electric or biofuel consuming versions • Review and update the Land Development Code to include incentives and allowances for electric vehicle infrastructure • Enact a policy for electric-vehicle ready new construction • Require large parking lots or garages (with 200 spaces or more) and public facilities to have EV charging stations	• Louisville Metro replaces its vehicles with more fuel-efficient options when possible
State Solutions	• No actions proposed	• No actions currently underway

Waste

The Waste sector deals with the emissions that result from the decomposition of waste generated by the community in landfills and emissions associated with wastewater treatment processes. Waste decomposition can create GHG emissions as a by-product, including methane.

Potential Contribution to Overall Reduction Target

In 2016, waste emissions accounted for 123,460 tCO_2e, or less than 1% of emissions in Louisville (**Figure 8**). Actions in this goal area encourage opportunities to capture methane released from the decomposition of waste materials at landfills and wastewater treatment facilities, as well as diverting organic waste from landfills.

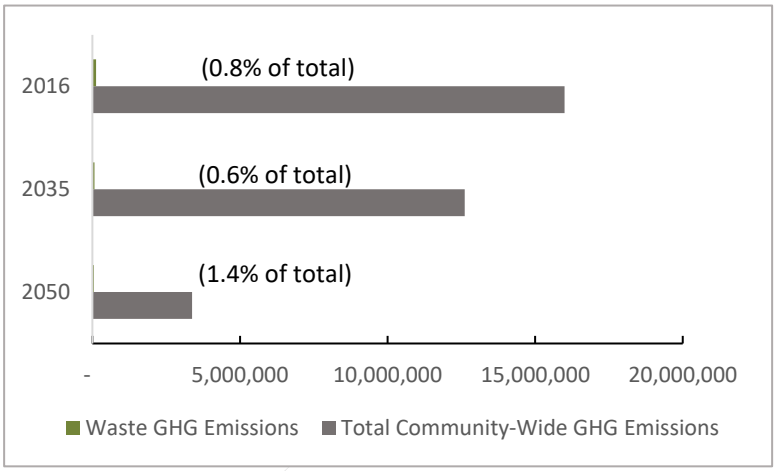


Figure 8. GHG Contributions by Waste Sector

Waste Management of Kentucky already recovers methane from the Outer Loop Recycling and Disposal Facility, though more than 20% of solid waste is currently processed at other facilities that lack methane recovery systems. There are many opportunities for methane capture at wastewater treatment plants located throughout Louisville.

Co-Benefits

Capture of methane produced by waste decomposition provides an additional source for locally produced energy through beneficial reuse of a waste product.

W-1. Organic Waste Diversion Programs

Description

This strategy is intended to build on the pilot organic waste diversion program in Louisville's Central Business District. This strategy establishes a permanent organic waste collection and diversion program. Development of this program will include preliminary waste data studies and tracking to develop a baseline of waste volumes, composition, and diversion rates. This will inform the viability of the program and decision-making on options for collection and management of organic wastes. Based on these upfront studies, an integrated waste management plan will be developed to promote waste sorting and diversion based on the principles of the circular economy.

Implementing an organics waste program could offer the potential for a cumulative avoidance of 37,177 tCO_2e by 2050, representing a 0.20% reduction in emissions over the BAU scenario.

W-1 Logistics

Timeline	Estimated Cost	Responsibility	Tracking Metrics
Medium-Term	Limited costs to complete planning studies and waste tracking programs. High costs to establish a Louisville Metro-wide integrated waste management program	Lead Agency: Public Works Key Partners: Waste Management, Rumpke, Eco-Tech, Westrock Recycling, Smith Creek	• Quantity of organic materials diverted from the landfill waste stream (tons)

W-1 Solutions

Financing/Policy Strategy	Implementation Actions	Status
Local Solutions - with funding needs	• Implement a community-wide waste tracking program to develop a baseline of waste volumes, composition and diversion rates across Louisville waste streams • Complete a study to assess the highest and best use of organic waste by stimulating end markets that recover value, reduce GHG emissions and, where possible, maintain the local nutrient cycle from organic waste streams. Implement the recommendations of the study • Develop additional incentives (financial or regulatory) for participation in waste reduction and recycling programs • Support non-profit, private and charity sectors in diverting food from the pre-waste stream for redistribution to food security organizations and projects • Re-establish Louisville's Wet-Dry Program and expand to cover the entire urban services district	• In 2016 Louisville Metro Public Works completed a Waste Characterization study to support the 2018 Solid Waste Study
Local Solutions - without funding needs	• Develop an integrated waste management plan that embraces the principles of the circular economy • Update Louisville Metro's procurement policy to include circular economy principles and performance metrics [22] • Increase efficiency and reduce the cost of collection services in unincorporated Jefferson County by transitioning over time to competitively bid collection zones that include recycling and composting without increasing costs to customers	• The 2018 Louisville Metro Government Solid Waste Study offers a set of recommendations for improving recycling and reuse, and reducing waste
State Solutions	• No actions proposed	• No actions currently underway

[22] Circular Economy: A framework for an economy that is restorative and regenerative by design. https://www.ellenmacarthurfoundation.org/circular-economy/concept

W-2. Methane Recovery from Wastewater Treatment Plants

Description

Methane produced as a by-product of wastewater treatment processes would be captured through the implementation of this strategy. The Louisville/Jefferson County Metropolitan Sewer District (MSD) already intends to upgrade treatment processes at the Morris Forman Water Quality Treatment Center to capture additional methane as an energy source in its boilers.

Improved efficiency, methane recovery efficiency technology and the introduction of methane recovery at all waste processing facilities could offer the potential for a cumulative avoidance of 1,714 tCO_2e by 2050, representing a 0.01% reduction in emissions over the BAU scenario.

W-2 Logistics

Timeline	Estimated Cost	Responsibility	Tracking Metrics
Short-Term	Limited costs from already planned and opportunistic upgrades at treatment plants	Lead Agency: MSD Key Partners: Mayor's Office, Metro Council	• Volume of methane captured at local wastewater treatment plants (m^3)

W-2 Solutions

Financing/Policy Strategy	Implementation Actions	Status
Local Solutions - with funding needs	• Where feasible, convert wastewater treatment facilities to anaerobic digestion technology that allowed methane capture and use • Implement water conservation programs to reduce energy usage requirements	• Planned upgrades to Louisville Metro MSD's Morris Forman Water Quality Treatment Center include methane capture technology
Local Solutions - without funding needs	• Seek to minimize energy consumption in drainage systems by ensuring that MSD-owned buildings are operated to minimize energy waste, operation schedules are well-designed to increase efficiency, and equipment is efficient and low-carbon emitting	• No actions currently underway
State Solutions	• No actions proposed	• No actions currently underway

W-3. Methane Recovery at Landfills

Description

Methane is already recovered from the Outer Loop Recycling and Disposal Facility. This strategy assumes that there will be a further 10% improvement in capture efficiency at this facility by 2050 resulting from technology improvements.

Approximately 20% of Louisville 's solid waste is processed at other facilities that do not have methane recovery systems in place. This action assumes that a 75% reduction in GHG emissions will be accomplished by introducing methane recovery systems at the other solid waste processing facilities that accept solid waste from Louisville. Waste reduction / diversion and improved methane recovery at waste processing facilities could offer the potential for a cumulative avoidance of 55,566 tCO_2e by 2050, representing a 0.3% reduction in emissions over the BAU scenario.

W-3 Logistics

Timeline	Estimated Cost	Responsibility	Tracking Metrics
Long-Term	Moderate costs to upgrade existing recovery systems and to install new methane recovery systems at other solid waste processing sites	Lead Agency: Public Works Key Partners: Waste Management, Rumpke, Clark-Floyd Landfill	• Volume of methane captured at local landfills (m^3)

W-3 Solutions

Financing/Policy Strategy	Implementation Actions	Status
Local Solutions - with funding needs	• Implement a waste tracking program to develop a baseline of waste volumes, composition and diversion rates across Louisville waste streams	• In 2016 Louisville Metro Public Works completed a Waste Characterization study to support the 2018 Solid Waste Study
Local Solutions - without funding needs	• Implement and upgrade landfill gas collection technology at landfills	• Waste Management of Kentucky began capturing natural gas at the Outer Loop Recycling and Disposal Facility in June 2018 • Rumpke has plans to begin construction of a methane capture system at their Medora landfill in 2020
State Solutions	• No actions proposed	• No actions currently underway

MONITORING AND REPORTING FRAMEWORK

Considering the nature of this ERP as a forward-looking vision for GHG emissions reductions in Louisville, it must be considered a living document. As new technologies are introduced and improved, new opportunities for emissions reductions may present themselves, while the efficacy of actions outlined in this plan may also be affected. Ongoing measurement and review will be beneficial to reframe and refocus the efforts of Louisville Metro and its community partners based on the most current and best available knowledge. To enable continued refinement of this plan, Louisville Metro will implement a monitoring program to track specific indicators of progress.

The monitoring framework will assist Louisville Metro with the following:

1. Measuring direct progress made toward the 2050 vision and associated sector targets for emissions reduction.
2. Measuring indirect indicators that will likely contribute to future emissions reductions (e.g., changes in transportation mode split, increases in renewable energy generating capacity, changes in the LG&E electricity grid).
3. Reporting on progress made in implementing supportive actions that will create an environment for sustained emissions reduction (e.g., new policies, bylaws, protocols, partnerships, etc.).
4. Overall data tracking on the number of actions completed, in-progress, and those that have not yet commenced.

Tracking and Reporting Protocol

Information and data will be recorded and tracked from all sources directly under Louisville Metro's control on an ongoing basis. This will include information pertaining to direct energy consumption, energy sources, on-site renewable energy generation, and on the status of internal policy and protocols relating to the actions identified in this plan.

Louisville Metro staff will provide regular updates indicating whether reduction measures are producing anticipated results and whether the emissions reduction target is likely to be met. This will be publicly reported on an annual basis through the release of a progress report. The complete community-scale inventory will be updated every 5 years to provide a current snapshot of community emissions and to enable measurement of progress and trends.

Updated inventories and annual progress reports will also be distributed to all key external stakeholders and to the Global Covenant of Mayors as required by Louisville Metro's participation in this program. Louisville Metro may also opt to voluntarily report data to other organizations and/or partners in future years.

Other objectives of reporting will include raising awareness and increasing understanding of GHG emissions, climate change, climate trends, and consequences with elected officials, Louisville Metro staff, and members of the community. This will build support for, and commitment to, the actions and strategies that can be taken within the community to support Louisville Metro in achieving its goals to reduce energy and GHG emissions.

Indicators

All actions in this ERP have been assigned quantitative or qualitative metrics that will enable tracking of trends over time relative to the baseline reported in this document and in the 2016 Community GHG Inventory. Indicators can be considered either process or outcome based. Process-based indicators are used to express whether Louisville Metro has enacted the right policies, protocols, and mechanisms to create an environment where the desired actions and outcomes can be achieved. Outcome-based indicators are backward-looking and will enable measurement of whether the desired outcomes have been achieved.

As a local government, Louisville Metro has the most influence initially through deploying process-based indicators to track and monitor progress. These are typically easier to implement quickly and can often be achieved directly through actions led by Louisville Metro. For example, establishing new policies or incentive programs is a qualitative action where progress can be measured simply by assessing whether new initiatives have been created and implemented.

As time passes, outcome-based indicators will become more important. In future years it will be expected that Louisville will begin to experience the impact of the process-based indicator actions as development, energy use, transportation, and lifestyle changes begin to shift. This outcome data will form the basis for tracking performance against the BAU and will ultimately determine the success or failure of new policies and initiatives.

Primary Reporting Indicators

Progress tracking will be achieved through use of the following outcome-based indicators for renewable energy generation and GHG emissions, as defined in **Table 6** and **Table 7**.

Table 6. List of Primary Reporting Indicators

Goal / Metric	Indicator	Measurement Units
80% reduction in community GHG emissions by 2050	Total GHG emissions from buildings in the community	Tonnes of carbon dioxide equivalent (tCO_2e)
	Total GHG emissions from transportation in the community	Tonnes of carbon dioxide equivalent (tCO_2e)
	Total GHG emission from waste in the community	Tonnes of carbon dioxide equivalent (tCO_2e)
	Total GHG emissions per resident	Tonnes of carbon dioxide equivalent (tCO_2e)
	Total renewable energy consumption in the community	Gigajoules (GJ)
Increased community renewable energy	Total renewable energy consumption in the community	Percent (%)
	Total cost of renewable energy / Gigajoule	USD$/GJ
80% reduction in local government GHG emissions by 2050	Total GHG emissions from Louisville Metro buildings operations	Tonnes of carbon dioxide equivalent (tCO_2e)
	Total GHG emissions from Louisville Metro transportation operations	Tonnes of carbon dioxide equivalent (tCO_2e)
	Total GHG emission from Louisville Metro waste operations	Tonnes of carbon dioxide equivalent (tCO_2e)
Increased local government renewable energy	Total renewable energy consumption from Louisville Metro operations	Gigajoules (GJ)
	Total renewable energy consumption from Louisville Metro operations	Percent (%)
	Total cost of renewable energy / Gigajoule	USD$/GJ

Table 7. List of Secondary Reporting Indicators

Indicator	Measurement Units
Total population	Number of people
Net new housing units by structural type	Number of units
New commercial and industrial space	m^2

Closing and Next Steps

This Emissions Reduction Plan presents a forward-looking framework for Louisville Metro to successfully achieve its target of 80% reduction in community GHG emissions by 2050, in keeping with the Global Covenant of Mayors commitment. Louisville Metro and its community partners will begin establishing an implementation plan for all actions in this report that are defined as short-term actions. Planning for mid- to long-term actions will be incorporated into future budgeting and work planning processes and documents beginning in 2020.

Appendices

Appendix A - Glossary

Agriculture, Forestry and other Land Use (AFOLU)
GHG emissions from livestock, land use and all other agricultural activities occurring within the city boundaries.

Anaerobic Digestion
A series of biological processes in which microorganisms break down biodegradable materials in the absence of oxygen. The end-product of this process is biogas, which is a renewable energy source that can be converted to renewable natural gas or as a fuel source for transportation.

Beneficial Reuse
Converting would-be waste products into a commodity valued by society.

Biomass
Organic material arising form plants and animals that serves as a renewable source of energy. Biomass contains stored energy from the sun. Burning biomass generates heat.

Business-as-Usual (BAU)
Baseline scenario that assumes very few things about our current way of life will change in the future that provides a reference point for us to measure our success or progress against.

Carbon dioxide equivalent (CO2e)
The amount of carbon dioxide (CO2) emissions that would cause the same integrated radiative forcing, over a given time horizon, as an emitted amount of a greenhouse gas (GHG) or a mixture of GHGs. The CO2e emission is obtained by multiplying the emission of a GHG by its Global Warming Potential (GWP) for the given time horizon. For a mix of GHGs, it is obtained by summing the CO2e emissions of each gas (IPCC 2014).

Carbon Intensity Factor
The emission rate of carbon by weight emitted or per unit of energy consumed.

Commissioning
Tests new building systems (heating, cooling, ventilation, hot water) and helps to ensure they are performing optimally and at maximum efficiency.

Deep energy retrofit
Deep energy retrofits aim to save 50% or more of the energy used on site in a building as compared to actual pre-retrofit usage or an estimate of energy use based on housing and climate characteristics. These savings are realized through improvements to the building shell including insulation and air sealing, and often through upgrades to high-efficiency heating, cooling, and hot water systems.

Demand-side management (DSM)
Actions that reduce end-consumer demand for energy. DSM strategies typically consist of incentives, education programs, building energy labelling programs, peak or load shifting, and the introduction of distributed energy generation and storage capacity.

ENERGY STAR
A U.S. Environmental Protection Agency voluntary program that helps businesses and individuals save money and protect our climate through superior energy efficiency. https://www.energystar.gov/

Feed-In Tariff (FIT)
Policy mechanism used to encourage deployment of renewable electricity technologies. A FIT program typically guarantees that customers who own a FIT-eligible renewable electricity generation facility, such as a roof-top solar photovoltaic system, will receive a set price from their utility for all of the electricity they generate and provide to the grid.

Fugitive
Emissions that are released during extraction, transformation and transportation of primary fossil fuels. These GHG emissions are not combusted for energy.

Greenhouse Gas (GHG)
Gases that trap heat in the atmosphere are called greenhouse gases. They include carbon dioxide, methane, and nitrous oxide. https://www.epa.gov/ghgemissions/overview-greenhouse-gases

Industrial Processes and Product Use (IPPU)
GHG emissions produced from industrial processes that chemically or physically transform materials and using products by industry and end-consumers (e.g., refrigerants, foams and aerosol cans).

International Building Code
The model building code developed by the International Code Council
https://www.iccsafe.org/products-and-services/i-codes/2018-i-codes/ibc/

Leadership in Energy and Environmental Design (LEED)
A framework for creating healthy, highly efficient and cost-saving green buildings.
https://new.usgbc.org/leed

Micro-generation technology
Small scale systems that generate electricity and/or heat.

Peak Demand
A period during which the demand for electrical power is expected to be sustained at a level higher than the average supply level. Typically, peak demand occurs during the day time, though peak demand is a factor of demographics, weather, climate, the season, and work schedules, among other factors.

Recommissioning
Tests performance of older buildings and identifies opportunities to upgrade and repair systems (heating, cooling, ventilation, hot water) to improve their efficiency.

Renewable Natural Gas (RNG)
Natural gas that is derived from organic waste material sources such as food waste, garden and lawn clippings, animal waste, paper, cardboard, wood, and solid waste.
https://www.epa.gov/lmop/renewable-natural-gas

Solar PV
Photovoltaic (PV) panels that collect sunlight and convert it to electricity.

Tonnes of carbon dioxide equivalent (tCO_2e)
Standard unit for measuring greenhouse gas, sometimes called metric tons (equal to 2,204 lbs or 1,000 kilograms). Estimates the impact of each different greenhouse gas in terms of the amount of carbon dioxide (CO_2) that would create the same amount of warming.

Transboundary GHG emissions
Emissions from sources that cross the geographic boundary (e.g., departing flight emissions from an airport outside the city boundaries).

Appendix B - Acronyms

APCD	Louisville Metro Air Pollution Control District
BAU	Business-as-Usual
BIAL	Building Industry Association of Louisville
CHP	Combined Heat and Power
CO_2	carbon dioxide
GCM	Global Compact of Mayors
GHG	Greenhouse Gas
GPC	Global Protocol for Community-Scale Greenhouse Gas Emission Inventories
HFC	hydrofluorocarbon
KIPDA	Kentuckiana Regional Planning & Development Agency
KPPC	Kentucky Pollution Control Center
KYTC	Kentucky Transportation Cabinet
kW	kilowatt
LEA	Louisville Energy Alliance
LED	Light Emitting Diode
LEED	Leadership in Energy and Environmental Design
LG&E	Louisville Gas & Electric
MSD	Louisville/Jefferson County Metropolitan Sewer District
PARC	Parking Authority of River City
PV	Photovoltaic
RNG	Renewable Natural Gas
TARC	Transit Authority of River City
tCO_2e	Tonnes of carbon dioxide equivalent
ULI	Urban Land Institute
WWTP	Wastewater Treatment Plant

Appendix C - References

C40 Cities. (2012). Why cities? Ending climate change begins in the city. https://www.c40.org/ending-climate-change-begins-in-the-city

Ellen MacArthur Foundation. (2019). Circular Economy. https://www.ellenmacarthurfoundation.org/circular-economy/concept

Global Covenant of Mayors for Climate and Energy. (2019). https://www.globalcovenantofmayors.org/

Forbes (2019). 4 U.S. Electric Vehicle Trends To Watch In 2019. Forbes. https://www.forbes.com/sites/energyinnovation/2019/01/02/4-u-s-electric-vehicle-trends-to-watch-in-2019/#686aa35c5a3c

IPCC (Intergovernmental Panel on Climate Change). (2018). Global warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty [V. Masson-Delmotte, P. Zhai, H. O. Pörtner, D. Roberts, J. Skea, P.R. Shukla, A. Pirani, W. Moufouma-Okia, C. Péan, R. Pidcock, S. Connors, J. B. R. Matthews, Y. Chen, X. Zhou, M. I. Gomis, E. Lonnoy, T. Maycock, M. Tignor, T. Waterfield (eds.)]. In Press.

IPCC (Intergovernmental Panel on Climate Change). (2014). Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, R.K. Pachauri and L.A. Meyer (eds.)]. IPCC, Geneva, Switzerland, 151 pp.

Jaffe, Amy, R. Dominguez-Faus, N. Parker, D. Scheitrum, J. Wilcock, and M. Miller. (2016). The Feasibility of Renewable Natural Gas as a Large-Scale, Low Carbon Substitute. Prepared for the California Air Resources Board and the California Environmental Protection Agency. Davis, CA: STEPS Program, Institute of Transportation Studies, University of California, Davis.

Louisville Metro. (2016). Move Louisville 2035 Transportation Plan. https://louisvilleky.gov/government/advanced-planning/move-louisville

Louisville Metro. (2018). Solid Waste Study. https://louisvilleky.gov/node/255521/

Louisville Metro. (2018). 2016 community greenhouse gas emissions inventory report. https://louisvilleky.gov/sites/default/files/sustainability/final_draft_louisville_2016_greenhouse_gas_inventory_report.pdf

Louisville Metro. (2019). Plan 2040: A Comprehensive Plan for Louisville Metro. https://louisvilleky.gov/government/planning-design/comprehensive-plan

SolSmart. (2019). https://www.solsmart.org/

Stern, Nicholas. (2006). The Economics of Climate Change: The Stern Review. Cambridge University Press.

United States Environmental Protection Agency. (2019). Renewable natural gas. https://www.epa.gov/lmop/renewable-natural-gas

United States Environmental Protection Agency. (2019). Combined Heat and Power (CHP) Partnership. https://www.epa.gov/chp/what-chp

Appendix D - Survey Results

Part 1: How likely are YOU to do the following?

Buy a programmable thermostat	Total	Percent
Likely	667	73.9%
Neither Likely Nor Unlikely	96	10.6%
Unlikely	136	15.1%
(blank)	4	0.4%
Total	903	

Adjust thermostat	Total	Percent
Likely	706	78.2%
Neither Likely Nor Unlikely	84	9.3%
Unlikely	105	11.6%
(blank)	8	0.9%
Total	903	

Install a renewable energy source	Total	Percent
Likely	290	32.1%
Neither Likely Nor Unlikely	222	24.6%
Unlikely	385	42.6%
(blank)	6	0.7%
Total	903	

Buy energy efficient appliances	Total	Percent
Likely	786	87.0%
Neither Likely Nor Unlikely	69	7.6%
Unlikely	38	4.2%
(blank)	10	1.1%
Total	903	

Use alternate mode of transportation at least once per week	Total	Percent
Likely	268	29.7%
Neither Likely Nor Unlikely	155	17.2%
Unlikely	475	52.6%
(blank)	5	0.6%
Total	903	

Use alternate mode of transportation more than once per week	Total	Percent
Likely	185	20.5%
Neither Likely Nor Unlikely	149	16.5%
Unlikely	562	62.2%
(blank)	7	0.8%
Total	903	

Buy electric or hybrid car	Total	Percent
Likely	313	34.7%
Neither Likely Nor Unlikely	213	23.6%
Unlikely	369	40.9%
(blank)	8	0.9%
Total	903	

Plant a tree on property	Total	Percent
Likely	681	75.4%
Neither Likely Nor Unlikely	106	11.7%
Unlikely	111	12.3%
(blank)	5	0.6%
Total	903	

Contribute financially to trees	Total	Percent
Likely	444	49.2%
Neither Likely Nor Unlikely	217	24.0%
Unlikely	234	25.9%
(blank)	8	0.9%
Total	903	

Part 2: Would you support the local enactment or legal requirements of the following?

Incentivize solar panels	Total	Percent
No	140	15.5%
No Opinion	48	5.3%
Yes	710	78.6%
(blank)	5	0.6%
Total	903	

Require programmable thermostats	Total	Percent
No	448	49.6%
No Opinion	129	14.3%
Yes	320	35.4%
(blank)	6	0.7%
Total	903	

Require solar on commercial buildings	Total	Percent
No	307	34.0%
No Opinion	110	12.2%
Yes	479	53.0%
(blank)	7	0.8%
Total	903	

Require commercial to report energy usage	Total	Percent
No	238	26.4%
No Opinion	86	9.5%
Yes	575	63.7%
(blank)	4	0.4%
Total	903	

Incentivize electric or hybrid vehicles	Total	Percent
No	199	22.0%
No Opinion	76	8.4%
Yes	621	68.8%
(blank)	7	0.8%
Total	903	

Provide EV charging stations	Total	Percent
No	110	12.2%
No Opinion	62	6.9%
Yes	603	66.8%

(blank)	128	14.2%
Total	903	

Increase parking fees	**Total**	**Percent**
No	477	52.8%
No Opinion	140	15.5%
Yes	278	30.8%
(blank)	8	0.9%
Total	903	

Offer discount for TARC riders	**Total**	**Percent**
No	98	10.9%
No Opinion	71	7.9%
Yes	729	80.7%
(blank)	5	0.6%
Total	903	

Incentivize carpooling	**Total**	**Percent**
No	136	15.1%
No Opinion	90	10.0%
Yes	670	74.2%
(blank)	7	0.8%
Total	903	

Provide additional curbside recycling options	**Total**	**Percent**
No	103	11.4%
No Opinion	77	8.5%
Yes	715	79.2%
(blank)	8	0.9%
Total	903	

Appendix E - 2020 Louisville Metro Clean Energy Resolution

A RESOLUTION FOR 100% CLEAN RENEWABLE ELECTRICITY FOR METRO GOVERNMENT OPERATIONS BY 2030, 100% CLEAN ENERGY FOR METRO GOVERNMENT OPERATIONS BY 2035 AND 100% CLEAN ENERGY COMMUNITY-WIDE BY 2040.

SPONSORED BY: COUNCILMEMBERS COAN, GEORGE, AND HOLLANDER

WHEREAS, "clean renewable electricity" is defined as electricity that: (1) can be extracted, generated, transported, and consumed with neutral carbon emissions or no emissions at all, and with no current or future significant threat to life and the natural environment; and (2) is generated and stored from renewable resources, which are naturally replenished on a human timescale, such as sunlight, wind, geothermal, tides, and, conditionally, bio-matter and various forms of hydropower. "Clean energy" encompasses electricity, transportation, buildings, and food systems; and

WHEREAS, according to the Sierra Club, "[a] community is powered with 100% renewable energy when the amount of energy generated from the renewable energy source equals or exceeds 100% of the annual energy consumed within the community."

WHEREAS, overwhelming scientific evidence affirms the existence of climate change and that the primary cause of recent climate change is human combustion of fossil fuels; and

WHEREAS, climate change has already brought devastating impacts in our nation and globally and, if unchecked, will fundamentally undermine the stability of economic, natural, and social systems, including the possibility of massive disruptions to human life on Earth; and

WHEREAS, more frequent and severe flooding, storms, and droughts in our own region pose similar threats to the stability of the local environment and economy, including human health effects; and

WHEREAS, there is no credible path to a safe climate that includes continued long- term combustion of fossil fuels and the proliferation of new fossil fuel infrastructure; and

WHEREAS, air pollution in the form of ozone and fine particulate matter brings about 46 deaths and 49,000 missed days of work or school in the Louisville metro area annually; and

WHEREAS, existing technologies have served this city well for over 100 years, but newer technologies suited for current and future conditions are now available; and

WHEREAS, local, state, and national economies are rapidly transitioning to 100% clean renewable energy along with multinational corporations and countries and cities globally; and

WHEREAS, Louisville Metro Government wishes to take full advantage of the new 21st century energy economy; and

WHEREAS, the Mayor is a signatory to the Mayors' Pledge to support the Paris Climate Agreement and the Mayor's Climate Compact to reduce greenhouse gas emissions, and the Metro Council unanimously adopted Resolution 079, Series 2015 to expand solar energy and efficiency in the city; and

WHEREAS, a just transition to 100% clean renewable energy will create high-quality local jobs; and

WHEREAS, youth and future generations will be more severely affected by climate change, and it is the duty of current leaders to act promptly and resolutely to mitigate climate change for their benefit; and

WHEREAS, low-income residents are often most burdened by energy costs and climate impacts, and Louisville Metro is committed to ensuring all residents enjoy the benefits of energy efficiency, clean renewable energy, electrified transportation, fair utility rates, and employment opportunities; and

WHEREAS, Louisville Metro's commitment to clean renewable energy will reduce carbon emissions and associated climate change, and reduce air pollution and associated public health risks and costs; and

WHEREAS, Louisville Metro's energy use could be substantially served by existing renewable energy and efficiency technologies and energy conservation at reasonable cost; and

WHEREAS, in 2017, 99% of electricity delivered to Louisville Metro consumers by utility companies was generated from fossil fuels – 80-90% coal and 9-19% natural gas – with only 1% from renewables; and

WHEREAS, given the accelerating rate of climate change, energy consumers, Louisville Metro, and utility companies must take strong action to quickly reduce carbon emissions and shift to 100% clean renewable energy for both Louisville Metro's operations and the entire community through technical and consumer changes that are within practical and economic reach; and

WHEREAS, achieving these energy goals will require broad input and concerted action from government, business, and community leaders, utilities, and individual citizens; and

WHEREAS, no one can predict what a final action plan will look like, one possible scenario might include: (a) reducing demand through conservation and energy efficiency policies and incentives; (b) creating electricity with many installations of solar panels on rooftops on solar farms; (c) creating storage for that electricity through batteries, phase change, and other upcoming technologies; (d) using the existing Ohio Falls Generating Station; (e) importing wind power with power purchase agreements (PPAs); (f) during the transition period, using existing fossil fuel energy temporarily; (g) offsetting local fossil fuel generation by purchasing renewable energy credits, (h) replacing fossil fuel-powered vehicles with electric or biofuel- powered ones, either through conversion or incentives and devising more efficient and convenient public transportation; and (i) creating a renewable energy trust fund, green bank, or other innovative financing mechanisms.

NOW, THEREFORE, BE IT RESOLVED BY THE LEGISLATIVE COUNCIL OF THE LOUISVILLE/JEFFERSON COUNTY METRO GOVERNMENT ("METRO COUNCIL") AS FOLLOWS:

SECTION I: Metro Council supports (1) a 100% clean renewable electricity goal for Metro Government operations by 2030, a 100% clean energy goal for Metro Government operations by 2035, and a 100% clean energy goal community-wide by 2040; (2) the revision of all building codes for new construction to require energy efficiency, conservation, and renewable energy applications toward an eventual goal of net zero or net positive energy, water, and waste for Louisville Metro; and (3) the opening of free market pricing for electrical generation and guarantee of total cost

access to the electrical grid in order to provide the public with cleaner and cheaper electricity.

SECTION II: Metro Council urges (1) Metro Government's forthcoming Climate Action Plan to support this goal; (2) public participation be prioritized in the planning, decision- making, and implementation process; and (3) underserved communities be brought into the political process to develop more just, equitable and sustainable energy systems and to facilitate more democratic ownership.

SECTION III: Metro Council adds to its priorities as Metro budget allows(1) energy efficiency and conservation projects, programs and outreach plus adding renewable energy infrastructure to reduce Louisville Metro's energy needs and carbon footprint and meet established Climate Action Plan goals; and (2) energy resources and programs that benefit low-income residents and create more equity in energy use, rates and jobs in the community.

SECTION IV: This resolution shall take effect upon its passage and approval.

H. Stephen Ott Metro Council Clerk	David James President of the Council
Greg Fischer Mayor	Approval Date

APPROVED AS TO FORM AND LEGALITY:

Michael J. O'Connell
Jefferson County
Attorney

By: _____

R-102-19 Clean Energy Resolution (12-5-19).docx